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PORTS AND
TERMINAL FACILITIES

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PORTS
AND
TERMINAL FACILITIES

BY

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To

ELLEN MacELWEE

My Wife

PREFACE

The announcement that a course was to be given at the School of Business, Columbia University, on "Ports and Terminal Facilities" brought many letters from various parts of the United States expressing the hope that the lectures would eventually be printed. As a result of this encouragement the material has been revised and presented in this volume.

The notice taken of the course indicates increasing interest in the broader economic aspects of the problem of efficient ports. Engineers, port officials, business men, and other progressive citizens are awakening to the fact that expensive harbor works alone, no matter how well constructed, do not make a port which will succeed in bringing commerce and wealth to a city. The need for better port and terminal facilities is not only a vital war measure but of continued and increasing importance in securing to the United States its place as the leading maratime power after the war.

What does make a successful port? There are complex ramifications and subtle interrelations of economic causes and effects which determine the prospects of success of a port.

It will be the effort of this volume to point out some of the factors which enter into the problem. If this discussion stimulates others to further investigation, study, and analysis of port problems the first hope for the usefulness of the book will have been realized. And if the book aids in bringing about a better understanding on the part of the general public of the importance of the subject to the nation and to the community, the second purpose will have been realized.

My own interest in ports extends back through nearly a score of years of travel and business abroad. Intensive study of the question began some six years ago while I was in charge of the Hamburg office of an American firm that built elevators and hoisting machinery. I had much to do with the authorities of the port and had occasion to view its operation at close range. Citations from this and other ports have been as general as possible to illustrate a principle but no attempt has been made to be exhaustive.

Due to a call into the national service the lectures and a large mass of material have been prepared for the printer in weeks, where months were considered too little. Thus the final presentation of the results of these years of study has been decidedly hurried. Several interesting features of the problem, such as finance, dues and income, the combination of beauty with utility in the waterfront, port administration, legal aspects of riparian rights and other points must be reserved for discussion in a possible second volume. The discussion of these points has been omitted not because they are of less importance, but because it must be postponed like so many others until after we have won peace.

I take this opportunity to acknowledge my indebtedness to Dr. T. W. Van Metre, Asst. Professor of Transportation at Columbia University, and Mr. W. M. Brittain, Secretary of the American Steamship Association, for valuable assistance in reading the manuscript and for suggestions and encouragement.

ROY S. MACELWEE.

NEW YORK,
June 15, 1918.

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PORTS AND TERMINAL FACILITIES

CHAPTER I

THE NATURE OF THE PROBLEM

The importance of ports and terminals in national economy has been brought home to all by the collapse of international transportation under the strain of war conditions. Ships are important, but it has been obvious, even to the casual observer, that a large part of the inefficiency and congestion which have hampered the movements of food and military supplies has been at the points of transshipment from land to water carriers. The port of New York has been congested at times until an almost complete paralysis of transportation has resulted. Word has frequently come to us that at Vladivostok cases of goods vital to Russia are piled househigh along the shores of the harbor.

As a war factor the port problem is a serious one. If there be no quick despatch of railway cars at the marine terminals, the inland transportation system of the country will be paralyzed and we shall have no coal nor many other things. We are sore pressed for ships, but if, because of the inefficiency of the ports and the railroads at the ports here and in France, we turn the ships around only fast enough to allow a round trip every twelve weeks instead of every six weeks the result is the same as if the Germans had torpedoed half of the existing meager tonnage. On the other hand, if we are able to coördinate and operate the terminal ports here and in France so as to turn the ships around quickly and make the round trip in six weeks instead of twelve, we have doubled the efficiency of our present merchant shipping without having built another ship. The port problem is as important a war question as the ship problem.

Furthermore, after the war, there will be a fierce commercial struggle to capture the markets of the world. Any parasitical expense at the terminals will act as an increased cost of production of American goods, for transportation is just as much a cost of production as raw materials or labor. If we are to hold and enlarge the markets for American goods, which will mean smoking chimneys and full dinner pails for American workers, we must scale down the unnecessary costs.

Mr. J. J. Hill, long ago, used the simile that the seaport was the funnel through which the commerce of the country flowed. He also enunciated the traffic law, "that the volume of traffic a line could carry could not exceed the capacity of the terminals." The conclusion, therefore, is that the commerce of the country flowing through the funnel of the great seaport is limited by the capacity of the terminal facilities of that port. The commerce of the United States overseas is therefore hampered or limited by the lack of development of the terminal facilities of our American seaports.

The marine terminal problem is a national and not a private one. The railroads have been interested in reducing the costs of the ton-mile over their own road bed, but have had little concern with the expenses at the terminals because these expenses in the major part are paid by the shipper, and ultimately by the consumers. The same may be said of the steamship lines. The terminal problem is not in the way of being successfully settled by private interests. Even Mr. Bush's great work is only a drop in the bucket. The creation of a successful port requires large constructive action on the part of municipal, state, and national governments to guide and correlate, and even to compel conformity to a definite policy to be followed by all interests concerned.

From the purely local viewpoint each consumer is concerned with this question. If the public carrier, the railway or ship company, is not particularly interested in the reduction of the "*frais parasites*" of transportation at the terminals, which adds its big bit to the high cost of living, the nation is. When viewed from the standpoint of national economy an unnecessary tax or parasitical expense on the cost of life is just as heavy to the ultimate consumer whether the railroad and ship companies pay this expense or the middleman. Progress in national wealth, prosperity, and civilization means a national surplus of production over and above consumption. Any unnecessary expenditure of national resources will devitalize the body economic of the nation by just that much. Human progress is made more rapid through each increase in efficiency that makes it possible to satisfy human wants with less expenditure of energy than before. If the cost of living is increased more than need be because of unnecessary expenses due to inefficient terminal facilities, the surplus of the people, which might be devoted to other things that go to make up the total of a higher standard of living, will be decreased. The long years of public indifference to the drag on its resources by unnecessary expenses of transportation at terminals have come to an end.

The extent to which the consumer is interested in the reduction of unnecessary expenses at the terminals may be illustrated by an example which shows how such an unnecessary expense, bad enough in its original outlay, becomes pyramided until it adds several times its own amount to the cost of the article to the ultimate consumer. The farmer received a certain sum, let us say 50 cents a bushel for potatoes, by way of illustration. The commission merchant must pay 20 cents to get the potatoes to New York. Of this 20 cents, 10 cents is an unnecessary expense due to inadequate facilities. The commission merchant to cover freight, shrinkage, profits and other items, adds 100%. The potatoes now cost the grocer $1.40. The grocer to cover costs and profit adds 50%, by which the potatoes cost the consumer $2.10. In the meantime the 10 cents excess expense at the terminals has become 30 cents. The orginal expense of 10 cents due to inadequate terminals costs the consumer 30 cents. These figures are illustrative and not actual, but careful analysis of actual conditions will show many instances of this kind of pyramiding. It certainly should be to the interest of every consumer to reduce the original parasitical expense which, thus increasing like a snowball at every turn over, adds to the already unbearable weight of the high cost of living.

There is little hope of large reductions in the present costs of steamship or railroad transportation. These forms of transportation have already been brought to a high state of efficiency. However, when the terminal problem is considered, conditions of inefficiency and parasitical expenses which swell the total of national waste are apparent at every step. It has been estimated that the average expense of hauling a ton of freight 240 miles in the United States is 74 cents, while the expenses of handling the same ton of freight at the terminals is 75 cents.[1] It becomes evident that the greatest hope of achieving further economies in transportation in the near future lies in the reduction of terminal expenses.

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[1] Grosvenor Jones, "The Ports of the United States."

Another example to illustrate the amount of terminal expenses as compared with the line haul is particularly crass because in this case the line haul is short and the two terminal cities are large.

Package freight is moved 90 miles by rail from Philadelphia to New York.

At Philadelphia the costs are:

Labor loading on wagon	25 cents per ton
Unloading at freight station	50 cents per ton
Railroad clerical work	40 cents per ton
Loading and switching freight and car	25 cents per ton
	$1.40

At New York the expenses are:

Terminal cost N. J. side, average of all railroads	15 cents per ton
Lighterage	80 cents per ton
Terminal cost Manhattan waterfront	50 cents per ton
Cartage in New York City	80 cents per ton
	$2.25
	$3.65 total

The railroad costs for 90 miles are 27 cents. The terminal expenses are nearly fourteen times the rail haul.[1]

In connection with the figures just quoted to illustrate the one-sided relation of terminal expenses to the line haul, it may be of interest to note the comparative expense of the line haul among various vehicles.

Dray on good roads	25 cents
Steam railroads	7.8 mills
Canals	3 mills
Rivers and sounds	1 mill
Great Lakes and ocean	0.5 mill[2]

Of course, such figures are only approximate and vary with conditions, yet the contrasts are so great that the illustrative force of the comparison is valuable for our future study of the problems.

---

[1] Harwood Frost, in pamphlet called "American Terminal Conditions." Also John A. Droege, "Freight Terminals and Trains," p. 273.

[2] H. C. Yost, *Freight Handling and Terminal Engineering*, Dec. 16, 1916.

The effect of high terminal expenses and high drayage charges as compared with low costs of water transporation is visualised by the statement that goods, once loaded, may move from Havana, Cuba, to Boston, Mass., 1,320 miles, cheaper than from one pier to another in Boston.[1]

A cargo of coal, once loaded, can be moved from New York to Rio de Janeiro at less cost than to move the pile back 60 feet by ordinary methods. With unloading charges varying from 12 cents to 45 cents per ton, a reduction of such charges by 12 cents is equal to a decrease of 250 miles of ocean steaming.

What is a Terminal?—A termi*nal* is the end of a movement in transportation. It may be either end. It may be for passengers or for goods. A termi*nus* is the end of a line. They are not the same although the termini of a railroad or of a steamship line are the most important terminals of the line. Add to this the consideration that in most cases of oversea transportation, the passengers or freight must pass from the terminus of the land carrier to that of the ocean carrier, or *vice versâ,* and the importance of the problem of connecting the two systems becomes evident.

What Do We Mean by Terminal Facilities?—*Terminal facilities are all those arrangements, mechanical and otherwise, which make easy the transference of passangers and goods at either end of any stage of the journey.* It is true that a large part of the problem is mechanical and belongs to the sphere of the engineer. There are all sorts of power-driven machinery for handling freight. The engineer is an important factor in constructing a terminal. However, cranes alone will not make a port and electrical trucks will not make a freight terminal, although mechanical equipment is indispensable.

The port or the freight terminals of a city must be considered as a unit, with all its parts designed and laid out in relation to the whole, coördinated into one instrument. Terminal facilities therefore comprise all the most ingenious mechanical, engineering, and architectural construction united into one definite policy and plan. We must, perforce, discuss minutely many details, many component units, but we must never lose sight of the ultimate function of the unit under consideration in the operation of the whole.

The port and terminal problem is one for both engineers and economists. There has been no real coöperation between the two sciences in the past. There has been a tendency to build wonderful piers as engineering structures which do not link up with the rest of the system, and there has been port planning which would not stand up because of the engineering deficiencies. The day has arrived when there must be a new profession of engineer-economist to solve involved transportation problems, just as the patent attorney must be an engineer. The building of efficient ports will require the best engineering talent that the land can produce. Our achievements on the Great Lakes in bulk cargo loading, transport, and unloading have far surpassed any like achievement abroad. Our American engineers are more than equal to the task if given the right conditions. The failure of our American ports in this crisis is not due to the engineers. The forces at fault are far less conspicuous and far more elusive. The failure of American ports at the present time is due to the peculiar conditions of American railway history, in particular to the competition of rival lines at the terminals. A new era in American railroading is dawning and it is for this new era that we must plan. Planning and execution will require engineering-economists.

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[1] Harwood Frost.

There is no short cut to the perfect port. Engineering-economist and administrator must coöperate. Just as in the design of an aeroplane, the way to make the machine light is to reduce the weight a little here and a little there. No one thing will do it. One little saving added to another little saving will in the end make a large difference in the weight of the motor, and so also in the cost of putting American products on the markets of the world.

In port design there are two mistakes that are easy to make. One is to perpetuate our own past errors and bad practices as a matter of habit or familiarity. The other is to copy bad practices from abroad along with the good by Chinese-copying successful foreign ports, under the delusion that *eo ipso* they will function when transplanted to America. We need to analyse our own requirements in the light of far-reaching knowledge of port conditions at home and abroad. In particular, as far as inland water transportation and port development are concerned, we must not hesitate to learn from the enemy. The great French engineering paper *Le Génie Civil* has been preaching this point constantly during the past two or three years. *Le Génie Civil* takes the stand that it is a peculiar kind of patriot who thinks it is unpatriotic to learn all that can be learned from the enemy. Such a patriot should be watched.

Not only engineers, economists, and administrators, but also the general public should be interested. The general public, which means the voters in a representative government, the sovereign people whose will rules, has considerable knowledge of railroad problems, and is rapidly learning much about shipping problems, but it has very little interest in or knowledge of the vital link between the two, the port. The time is opportune for a more general knowledge of the subject of ports and terminals. The war should have demonstrated that ports and terminals are the concern of every citizen of our great Republic.

TERMINOLOGY

What is a Port?—The question may be answered in the Yankee manner by asking, what is a harbor? A harbor is a sheltered body of water of sufficient depth to enable a ship to find shelter in it from the storms of the high seas. *If to a harbor or haven we add terminal facilities we have a port.* The terms are used loosely. The very looseness of port terminology indicates how little scientific thought has been expended on the problem. Even in a highly developed port such as Rotterdam or Hamburg, the excavated basins called by the French "bassin" are called "harbors;" for instance, the Petroleum Haven, Entrepôt Haven. So we find that harbors are a part of a port and when facilities are concerned we find that the port is only a part of the harbor. In order to be clear concerning the terminology to be used in our coming discussion we may define some equivocal terms.

Mr. Grosvenor Jones has endorsed the nomenclature suggested by Mr. W. J. Barney, Secretary of the American Association of Port Authorities. As the definitions stated by these gentlemen are thoroughly sound we may well abide by them and quote them verbatim for future use.[1]

In a paper on "Types of American Public Wharf Construction," Mr. Barney made the following distinction between types of water terminals: "**Wharf** is the general term for a landing place for vessels and cargoes.

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[1] "Ports of the United States," GROSVENOR M. JONES, Department of Commerce, Bureau of Foreign and Domestic Commerce, *Miscellaneous Series* No. 33, Washington, 1916, pp. 23–24.

A pier is a wharf structure that projects into a stream or fairway.

Slips are the open water spaces or docks between adjacent piers.

Quays are wharves parallel to or lying along the shore."

It has not always been possible to adhere to these distinctions, since at a number of ports the terms "wharf" or "dock" have long been commonly used in the designation of terminals. Thus at Boston some of the piers along the Atlantic Avenue waterfront have been known for scores of years as India Wharf, Lewis Wharf, "T" wharf, etc., and at certain ports on the Great Lakes, the iron-ore and coal terminals have been generally and for years referred to as "ore-docks." Words that adequately describe the form of construction have not been used in such cases.

The term "dock" is properly used in describing the type of terminal in which the slips or basins adjacent to the wharves are provided with locks and gates.[1] At the English ports of Liverpool and London, and many others, docks are necessary on account of the great range of tides, but in this country extreme ranges of tides are not factors in the character of terminal construction.

In a discussion of port administration in the United States it is desirable that a distinction be made between the harbor and the port. The harbor may be defined as consisting of the waterways and channels as far in as the pierhead lines, and the port is including everything on the landward side of those lines, that is, the piers, slips, wharves, sheds, tracks, handling equipment, etc. This distinction, while technical and somewhat novel, tends to mark off distinctly the limits of the jurisdiction of the Federal Government and the jurisdiction of the State and municipal authorities. It can not be strictly observed in the present work because of the strength of prevailing local usage, which fails to distinguish between harbor and port.

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[1] See "Docks," Encyclopædia Britannica.

CHAPTER II

THE RELATIVE IMPORTANCE AND PHYSICAL CHARACTERISTICS OF THE WORLD'S LEADING PORTS

In order to orient ourselves as to the relative importance of the ports of the world which we are going to scrutinize it may be well to consider a few statistics.

A word of warning must always be sounded in dealing with statistical material. This is especially true in the case of seaports. First there is a wide variation in the measurement of vessels. For instance in the case of Antwerp the tonnage of the port as given in the Belgian statistical abstracts is between 14% and 15% higher than the record of the movement of the same vessels at an English port would be.

Then it is unfortunate that some ports measure the movement by the value of the merchandise. This is the usual practice in the United States. With a rise of prices the comparative movement of the various ports will be out of proportion to the actual increase.

This is not as bad, however, as the measure of commerce by the tonnage of merchandise alone. A port such as Cardiff, where the entire movement is in coal, when judged by tonnage, seems to be a far more important commercial center than it really is. In like manner it is hardly of value to compare the tonnage of the "Soo" Canal with the Suez Canal, and point to the fact that 27,000,000 tons of shipping pass through the Suez canal in a year, while 22,000,000 tons pass through the "Soo" Canal in the single month of August.

It is also necessary to keep in mind that statistics may refer to cargo tons, displacement tons, register tons, long, short, and metric tons. Comparisons, with mental reservations, follow.

VALUE OF IMPORTS AND EXPORTS AND NET TONNAGE OF VESSELS ENTERED AND CLEARED IN FOREIGN TRADE AT THE PRINCIPAL SEAPORTS OF THE WORLD

Ports	Year	Value of imports	Exports	Total	Net tonnage of vessels	
					Entered	Cleared
New York	1910	$935,990,956	$651,986,356	$1,587,977,314	13,042,318	12,541,903
London	1909	1,000,746,471	569,256,326	1,570,002,792	11,605,698	8,622,316
Liverpool	1909	723,146,084	723,131,030	1,451,277,114	7,747,994	6,593,094
Hamburg	1909	810,179,970	578,343,753	1,388,523,723	11,061,041	11,247,191
Antwerp	1909	529,626,422	444,845,196	974,471,618	11,907,689	11,894,492
Hong Kong	1909	....	....	....	11,150,560	11,194,098
Rotterdam	1910	....	....	....	9,217,493	8,902,570
New York	1911	881,592,689	772,552,449	1,654,145,138	13,428,950	13,366,869
London	1910	1,110,828,205	643,014,124	1,753,842,329	12,154,162	8,999,635
Liverpool	1910	828,620,152	829,250,836	1,657,870,988	7,588,653	6,697,512
Hamburg	1910	872,629,975	661,480,352	1,534,110,327	11,417,773	11,583,211
Antwerp	1910	560,994,911	523,075,033	1,084,069,944	12,654,318	12,625,165
Rotterdam	1910	....	....	....	10,649,843	10,490,049
Hong Kong	1910	....	....	....	10,489,203	10,477,301
New York	1912	975,744,320	817,945,803	1,793,690,123	13,673,765	13,549,138
London	1911	1,119,238,957	672,618,684	1,791,857,641	11,973,249	9,004,974
Hamburg	1911	962,925,352	711,261,824	1,674,187,176	11,830,949	11,945,239
Liverpool	1911	773,225,287	859,055,190	1,637,280,447	7,887,719	6,880,271
Antwerp	1911	594,472,069	527,182,730	1,121,654,799	13,330,699	13,325,781
Rotterdam	1911	....	....	....	11,052,186	10,800,490
Hong Kong	1911	....	....	....	10,246,022	10,243,098
New York	1913	1,048,290,629	917,935,988	1,966,326,617	14,464,161	14,370,619
Hamburg	1912	1,096,550,183	864,229,672	1,960,779,855	13,567,913	13,837,076
London	1912	1,164,769,445	702,161,337	1,866,930,782	10,800,716	8,748,008
Liverpool	1912	872,320,787	944,662,492	1,816,983,279	7,253,016	7,446,873
Antwerp	1912	....	....	....	11,483,214	11,453,859
Rotterdam	1912	....	....	....	11,552,119	11,532,619
Hong Kong	1912	....	....	....	12,179,035	12,100,365
New York	1914	1,040,380,526	864,546,338	1,904,926,864	15,767,547	15,421,394
Hamburg	1913	1,084,324,537	817,274,716	1,901,599,253	14,185,000	14,440,000
London	1913	1,235,503,560	768,482,933	2,003,986,493	13,725,156	11,403,908
Liverpool	1913	854,020,794	950,368,220	1,804,398,014	12,054,056	11,209,415

The statistical tables of foreign countries are usually for the calendar year ending with December 31. In the United States the tables are made up for fiscal years that end on June 30. So that New York, while seemingly a year in advance, or a year behind, in comparative tables based upon years, is, in reality, but six months ahead or six months behind, as the case may be.

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[1] Compiled from "Commerce of the Ports of the World," R. A. C. SMITH, New York, 1915.

TONNAGE OF VESSELS IN FOREIGN TRADE ENTERED AT LEADING UNITED STATES PORTS BY SINGLE YEARS FROM 1830 TO 1915

	New York, N. Y.		Philadelphia, Pa.		Boston, Mass.		New Orleans, La.		Baltimore, Md.		Galveston, Tex.	
	Entered, tons	Per cent.	Entered, tons	Per cent.	Entered, tons	Per cent.	Entered, tons	Per cent.	Entered, tons	Per cent.	Entered, tons	Per cent.
1830	305,181	27.7	77,016	7.0	113,238	10.3	... .	....	61,121	5.5		
1841	547,694	23.9	39,070	1.7	291,323	12.8	....	....	89,748	3.9		
1850	1,145,331	30.5	132,370	3.5	478,859	12.8	349,949	9.3	99,588	2.7	2,9	0.08
1860	1,973,812	39.4	182,162	3.6	718,587	14.3	632,398	12.6	186,417	3.7	32,263	0.06
1870	3,093,186	49.0	300,006	4.8	793,927	12.6	458,447	7.3	272,290	4.3	31,555	0.05
1880	7,611,282	49.9	1,391,312	9.1	1,347,447	8.8	760,910	5.0	1,502,713	9.8	117,972	0.07
1881–1890 (average)	6,181,931	46.5	1,093,541	8.0	1,327,234	9.8	759,458	5.6	744,153	5.5	134,808	0.1
1891–1900 (average)	7,241,695	38.3	1,566,639	8.3	1,816,206	9.6	1,224,376	6.4	1,115,134	5.9	474,743	2.5
1901–1910 (average)	10,516,817	38.8	2,112,097	7.8	2,761,388	10.1	1,789,421	6.6	1,377,365	5.0	867,963	3.2
1911	13,428,950	41.2	2,672,883	8.2	2,836,611	8.7	2,019,067	6.2	1,279,487	3.9	830,272	2.5
1912	13,673,765	39.3	2,700,193	7.7	2,948,244	8.4	2,214,681	6.3	1,192,037	3.4	1,025,257	2.9
1913	14,464,161	38.6	2,883,975	7.6	3,069,111	8.1	2,545,241	6.7	1,593,794	4.2	1,443,767	3.8
1914	15,767,547	39.3	3,787,219	9.4	3,363,100	8.3	2,851,265	7.1	1,477,493	3.6	1,382,633	3.4
1915	12,579,000	35.9	1,939,000	5.2	2,464,000	6.1	3,064,000	5.9	2,043,000	7.3	1,562,000	5.6

Authority, statistical abstracts of United States Bureau of Foreign and Domestic Commerce.

A graphic representation of the comparative tonnage of the leading world's ports is shown in Fig 1.

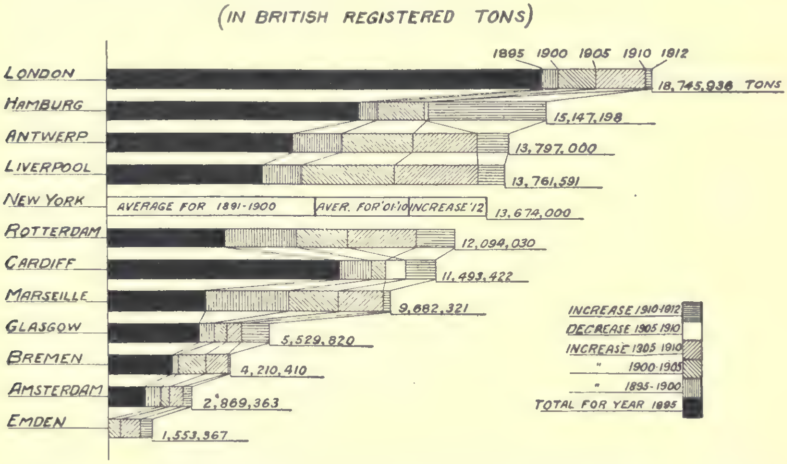

FIG. 1.—Total overseas commerce entered. (From "The Harbor of Rotterdam," published by the Municipality of Rotterdam, 1913. Except New York.)

TWELVE GREATEST PORTS OF BRITAIN AND U. S.[1] IN 1916.
Total Trade, 1916 (Excluding Coastwise Shipments.)

Port	
New York	$4,048,137,562
London (including Queensborough)	2,739,127,665
Liverpool	2,380,929,800
Hull	433,831,670
Philadelphia	428,544,597
Boston	386,915,297
Glasgow	379,396,970
Seattle	360,526,940
New Orleans	358,717,194
Manchester (including Runcorn)	346,269,470
Baltimore	330,109,362
Galveston	260,918,215
Total trade of U. S., 1916	$7,873,077,924
Total trade of United Kingdom	$7,761,761,885

There are other outstanding characteristics of ports which enable various classifications to be made other than by mere statistics.

1. Distance from the High Seas.—Many of the great seaports of the world are far from the sea. They are situated on rivers or canals. The port itself in its modern form has been dug out of the banks of the river. The upland has been turned into harbors. The channel to the sea, once sufficient for the merchant ships of a century ago, is now kept at a depth sufficient for the modern leviathans by constant dredging to prevent the ancient seat of a thriving oversea commerce from becoming an inland village. Such dredging costs are a severe financial handicap quite aside from the great difficulty of navigation.

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[1] From *Journal of Commerce.*

There is an historical reason for the location of seaports far inland. When the seaports which are great to-day were first founded, travel by land or sea was very dangerous. Depredations by pirates, marauders, and hostile tribes or nations were frequent. The early merchants therefore went as far up stream as the draft of their ships would permit, to get as far away as possible from the sea with its lurking dangers. Also, inland commerce was carried on over the navigable inland waterways which were safer and much cheaper avenues of transportation than the caravan routes on the highroad. Therefore the towns of London, Bordeaux, Antwerp, Bremen, Cologne, Hamburg, and many more are situated at the point where the ocean and the river vessels could meet as far from the high seas as possible. Rome, Paris, Cologne, and others of these ports of the classic and middle ages have ceased to be seaports. Others have saved themselves from becoming inland cities by the development of the steam dredge to provide for the increased draft of steamships. Some very modern ports, such as Manchester, and Houston, Texas, always have been inland cities until civil engineers connected them with the ocean by canal (Fig. 2).

To mention only a few of the ports which are situated inland, we will find the following examples:

	About
New Orleans	106 miles from the Gulf of Mexico.
Philadelphia	105 miles from the Delaware Bay.
Baltimore	151 miles from Hampton Roads.
Portland, Ore	112 miles from the Pacific Ocean.
Richmond, Va	104 miles from the Atlantic Ocean.
Wilmington, Del	82 miles from the Atlantic Ocean.
Jacksonville, Fla	27½ miles from the Atlantic Ocean.
Sacramento, Cal	111 miles from the Pacific Ocean.
Houston, Texas	50 miles from the Gulf of Mexico by canal.
Amsterdam, Holland	15 miles from the North Sea by canal.
Manchester, England	35½ + 19 miles from the Irish sea (35½ miles by canal and 19 miles by river.
Rotterdam	18 miles from the North Sea

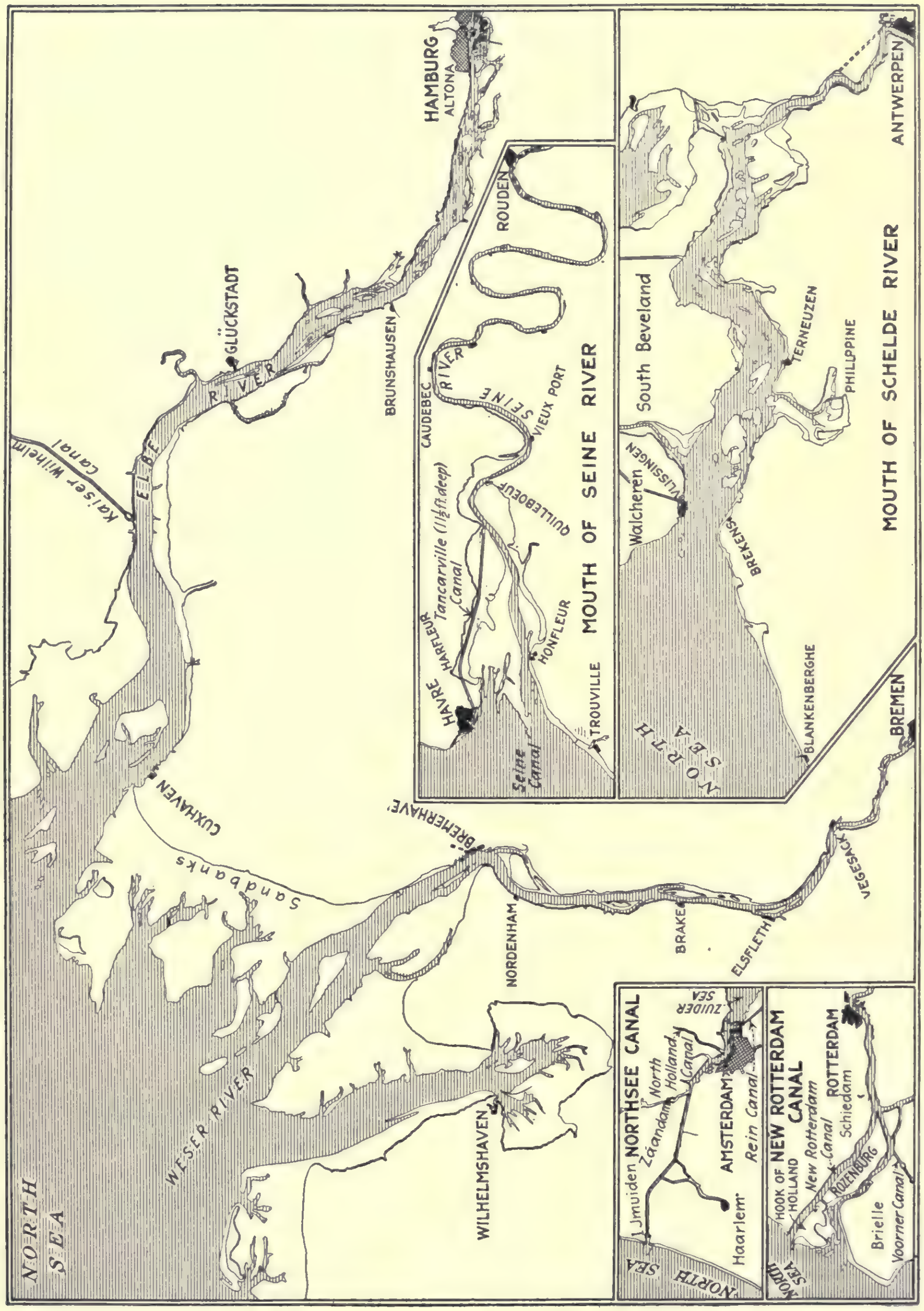


FIG. 2.—Mouths of harbors on the Weser and the Elbe.

Bremen	54 miles from the North Sea.
Hamburg	67 miles from the North Sea.
Antwerp	50 miles from the North Sea.
London	67 miles from the North Sea.
Liverpool	3 miles from the Irish Sea.
Nantes	78 miles from the Atlantic Ocean.
Bordeaux	60 miles from the Bay of Biscay.

2. The ports like Tyre, "*Situate at the entry of the sea,*" Ezekiel XXVII: 2, need little explanation. These ports are located on natural bays or harbors. New York, Boston, Tacoma, Vancouver, Havre, Manila, Buenos Ayres, Southampton, Cherbourg, Copenhagen, are examples of this kind of port. Such ports have a great advantage, in time saved, in water depth, and in area.

3. The range of tide, which determines whether harbor works are to be built with docks or with tide water basins and slips, gives another distinction. The difference in the water level of the harbor at low and at high tide is a very important factor. The rule has been that a range of tide of more than 12 feet makes it necessary to have locks and docks. The modern tendency has been to bear with the range of tide rather than undergo the delays occasioned by docks.

New York has a range of only 4½ feet, Baltimore only one foot, Galveston only 1½, while Boston has a range of 9½ feet, and Tacoma, Wash., 13 feet. This is very little compared to Liverpool or Havre with a range of 25 feet to 30 feet. At Rotterdam there is a five-foot range of tide, at Hamburg about six feet, while at Antwerp there is a difference of 13 feet, between high and low tide.

Ports[1]	Minimum depth, ft.	Mean range of tide, ft.	Maximum depth, ft.
Boston, Mass	35.00	9.50	44.50
New York, N. Y	40.00	4.50	44.50
Philadelphia, Pa	(*b*)30.00	6.00	36.00
Portland, Me	30.00	9.00	39.00
Baltimore, Md	35.00	1.00	36.00
Galveston, Tex	30.00	1.25	31.25
New Orleans, La	31.00	......	31.00
Portland, Ore	(*c*)28.00	7.00	35.00
Tacoma, Wash	(*e*)	13.00	(*e*)

(*b*) Being dredged to 35 feet.

(*c*) Being dredged to 30 feet.

(*e*) Deep enough for any draft.

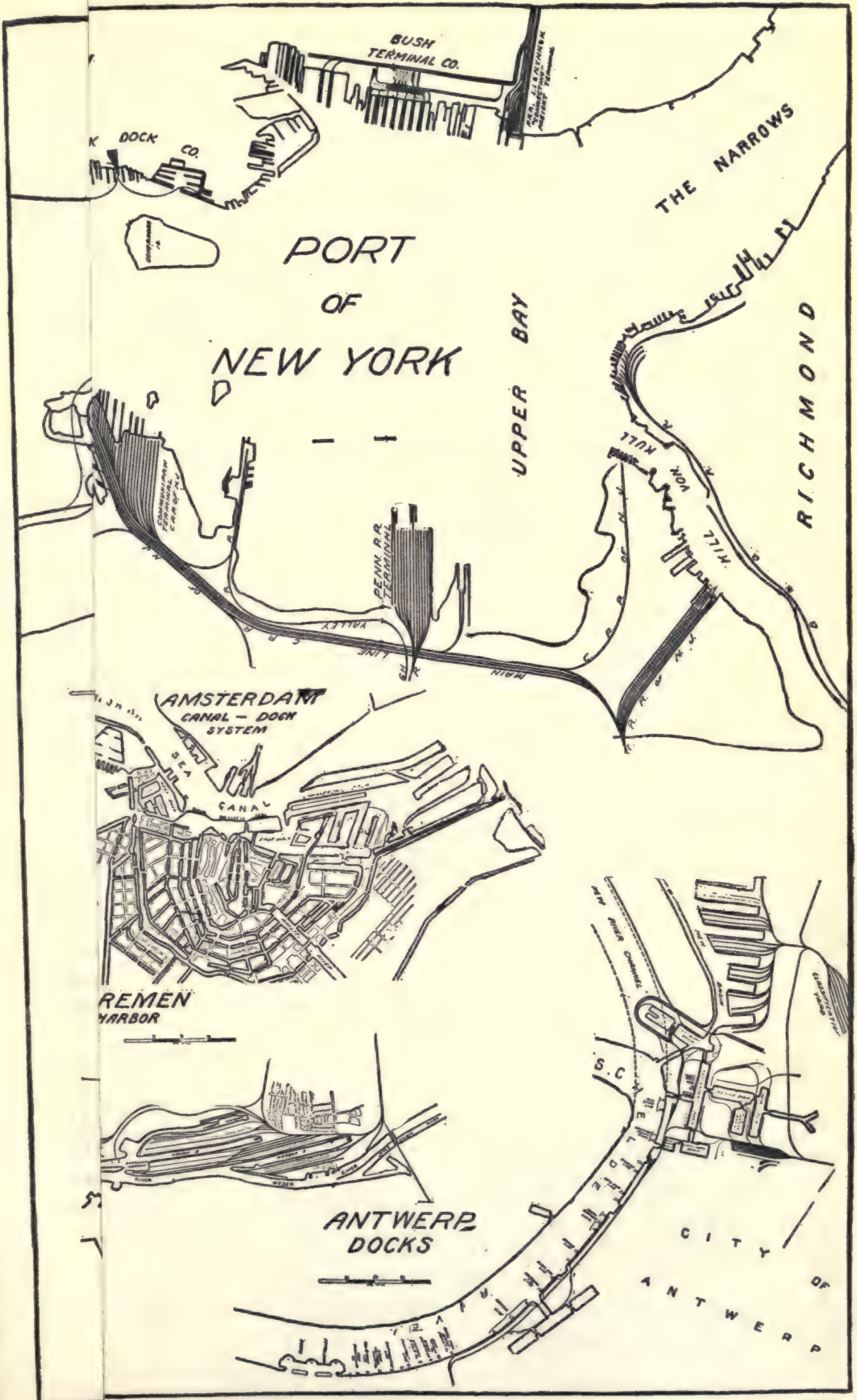
[1] GROSVENOR JONES.

4. Depth of channel to the landing place has come to be an important feature as distinguishing one port from another. The recent 50,000-ton class of ship such as the "Aquitania" and the "Vaterland" require a channel to the berth of at least 40 feet. There are only four ports in the United States which have such a channel. New York has a dredged channel of 40 feet to some parts of the harbor, but by no means to all. The East River has been badly neglected as to channel. The present agitation for a back door entrance to the harbor of New York through Hell Gate for our fleet has prospects of bringing about the extension of necessary harbor deepening. San Francisco has a natural depth of 60 feet in nearly all parts of the harbor, while Seattle and Tacoma are "very deep." Boston has a low-water depth of 35 feet, which would enable the largest ships to enter at high tide, when the depth is 44½ feet. Philadelphia has a channel of 36 feet in depth at high tide.

Harbor depths put a very rigid limit on the size of the ships which may enter at any given port. Channels have been dredged deeper and deeper, at great cost, to accommodate increasingly large ships. However, the time has come when port authorities and municipal exchecquers must take a stand against being required to spend millions to deepen a channel a foot or so more in order to accommodate some private steamship line which wishes to own "the biggest ship in the world" for advertising purposes.

5. Port improvements are of two distinct types, the European plan of solid quays, and the American plan of pile piers, or wharves in the case of rivers too narrow for piers. The European ports on the rivers almost always have solid filled quays along the river proper as well as facing the excavated harbor basins. This difference between the American and the European harbor plans is fundamental, yet on close analysis the principles of smooth freight movement involved will be seen to be identical.

6. The Efficiency of a Port Is Not Its Size.—A map (Fig. 3) illustrating the "Biggest-in-the-World" idea in the case of New York shows a map of the Port of New York occupying one-half of the page. Drawn to the same scale the ports of Hamburg, Rotterdam, Liverpool, London, Amsterdam, Bremen, and Antwerp all together occupy the other half. Instead of being a cause of pride this is a sad commentary on the efficiency of New York as a port. It does indicate the size of the problems con-


BUSH TERMINAL CO.
K DOCK CO.
THE NARROWS
PORT OF NEW YORK
UPPER BAY
RICHMOND
KILL VON KULL
COMMUNIPAW TERMINAL C.R.R. OF N.J.
PENN. R.R. TERMINAL
VALLEY
LINE
MAIN
AMSTERDAM CANAL – DOCK SYSTEM
SEA
CANAL
REMEN
HARBOR
ANTWERP DOCKS
NEW RIVER CHANNEL
S.C.
CITY OF ANTWERP

fronting our greatest gateway, but when we consider that each of the other little dug-out-of-the-mud ports has handled almost as much commerce as all of New York without breaking down, we realize that there must be something wrong with the Port of New York. Several European ports, notably Marseilles, average yearly more than 1,500 tons of cargo transferred over every linear foot of equipped quay as against 150 tons at New York.[1] It is not size that makes a port, but efficiency.

For the sake of defining clearly what we are talking about, we must call attention again to the use of the word *dock*. It is used incorrectly on this map in several places. At Hamburg there are no docks but open tidal basins. At Bremen, Antwerp, and London there are docks.

Comparison of Port Layouts (see Figs. 4 to 11). Antwerp, before the war, had planned one of the greatest digging efforts in all the long list of excavated ports, but the port of Antwerp suffers from the conflict of municipal and state authorities. The plan was afterwards abandoned. The idea was to dig a canal called the "Grand Coupure" across the bend in the Scheldt and then construct a lock canal several miles long with nine basins 3,000 feet to 3,500 feet long, and 300 feet to 400 feet wide. These basins were to be added as the demands of commerce required and were to be fully equipped with cranes, sheds, spur tracks, and upland for classification yards, warehouses, and industrial development. The old basins, some of which date from Napoleon Bonaparte's time, are small affairs in comparison.

Bordeaux also intended to build a dock harbor on the locked canal and side-arm-basin principle. This has been commenced. The structures which look like piers on the map are not piers in the American sense, but tongues of land several thousand feet long faced with masonry quay walls. Pile structures are not practical in such large units.

Manchester, the inland town which became a port, has docks and quays. The longest docks are 2,700 feet by 300 feet. It seems that in Europe, whenever a harbor is dug out of the ground, the quay system and not the pier system prevails. Most of these harbors are dug out of low-lying marsh land and the material excavated by the dredge is used to fill the land to a sufficient height for building construction.

Tilbury docks, London, are an excellent example of the dock

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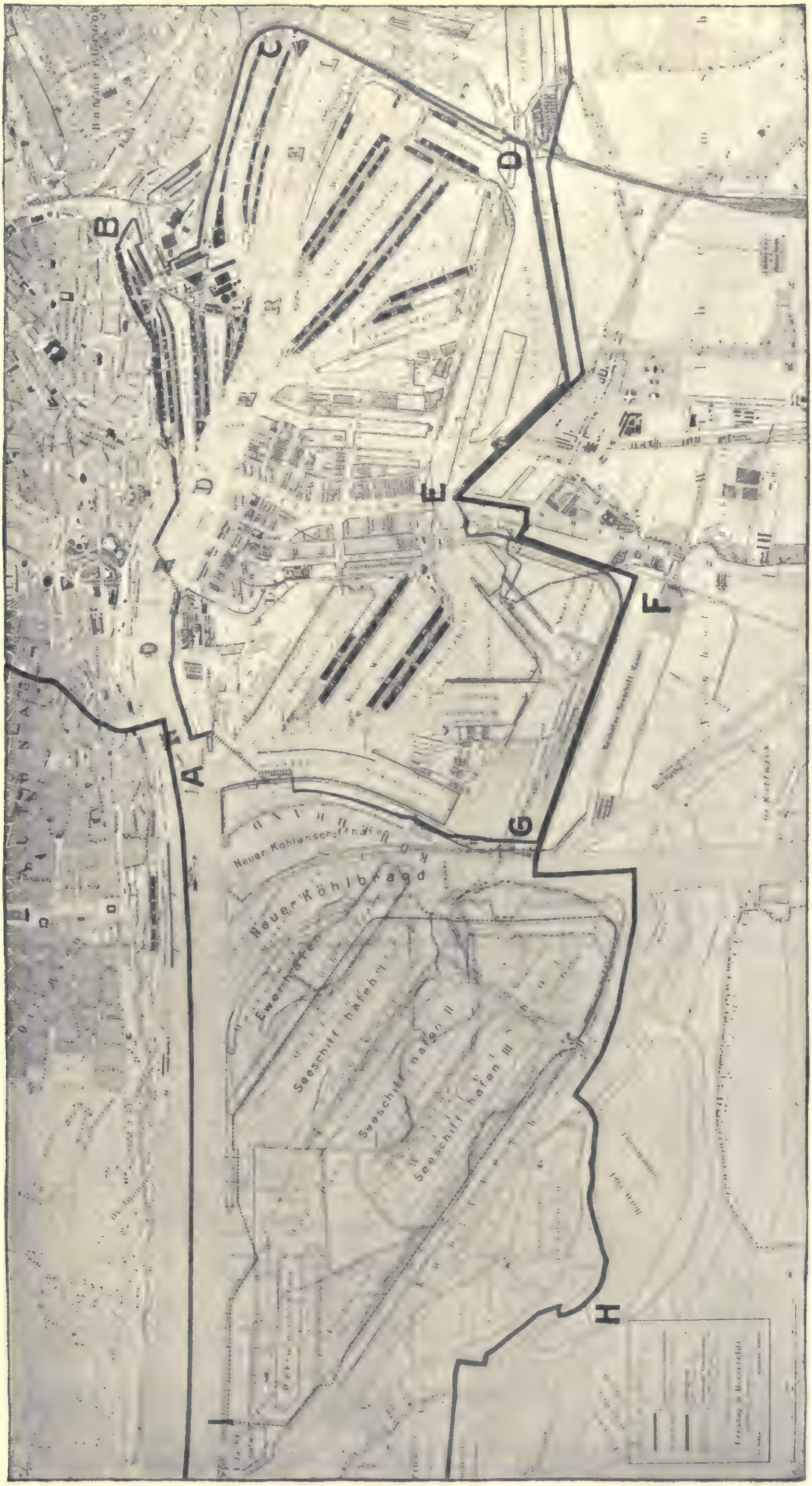
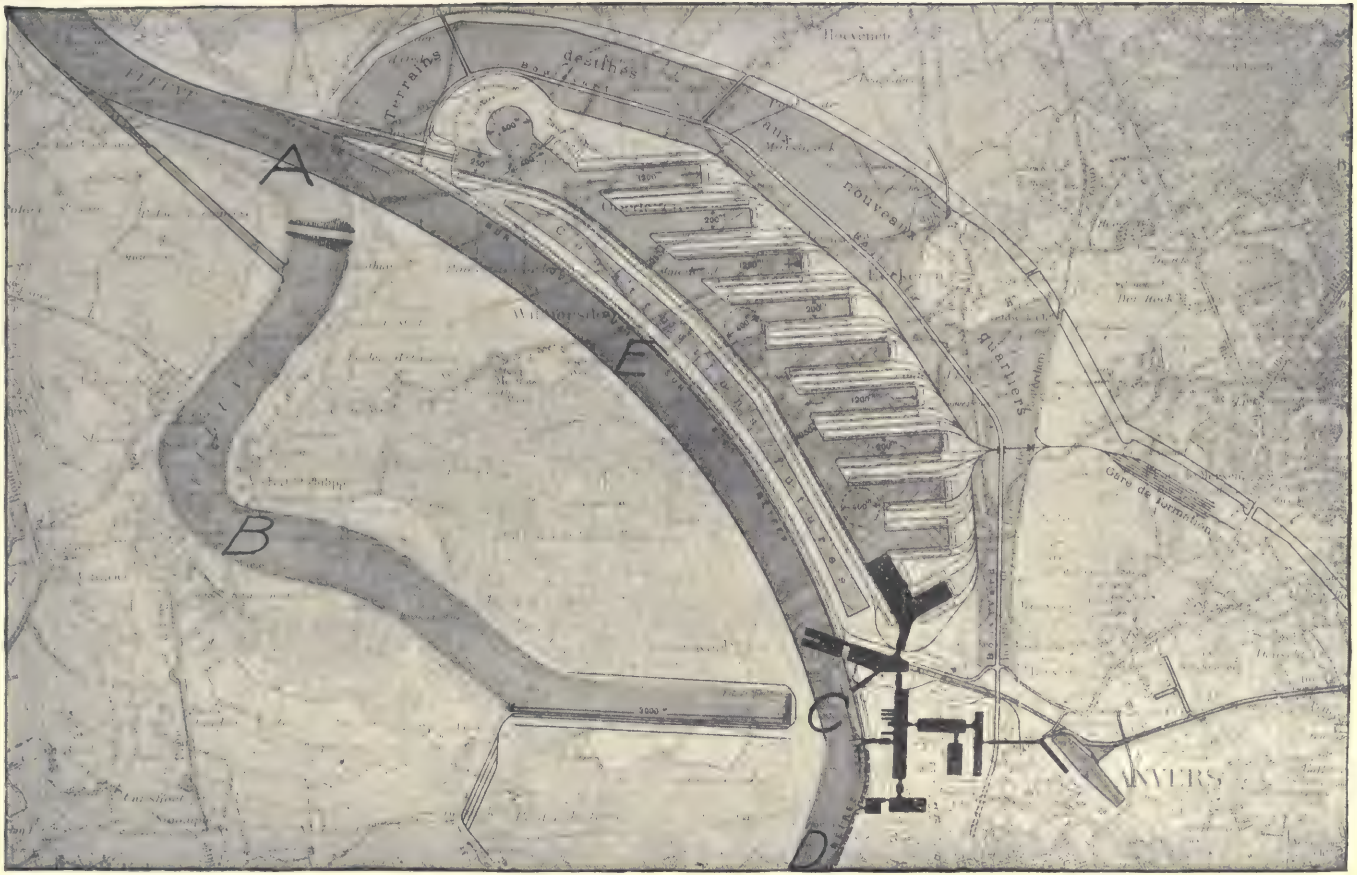
[1] H. McL. Harding.



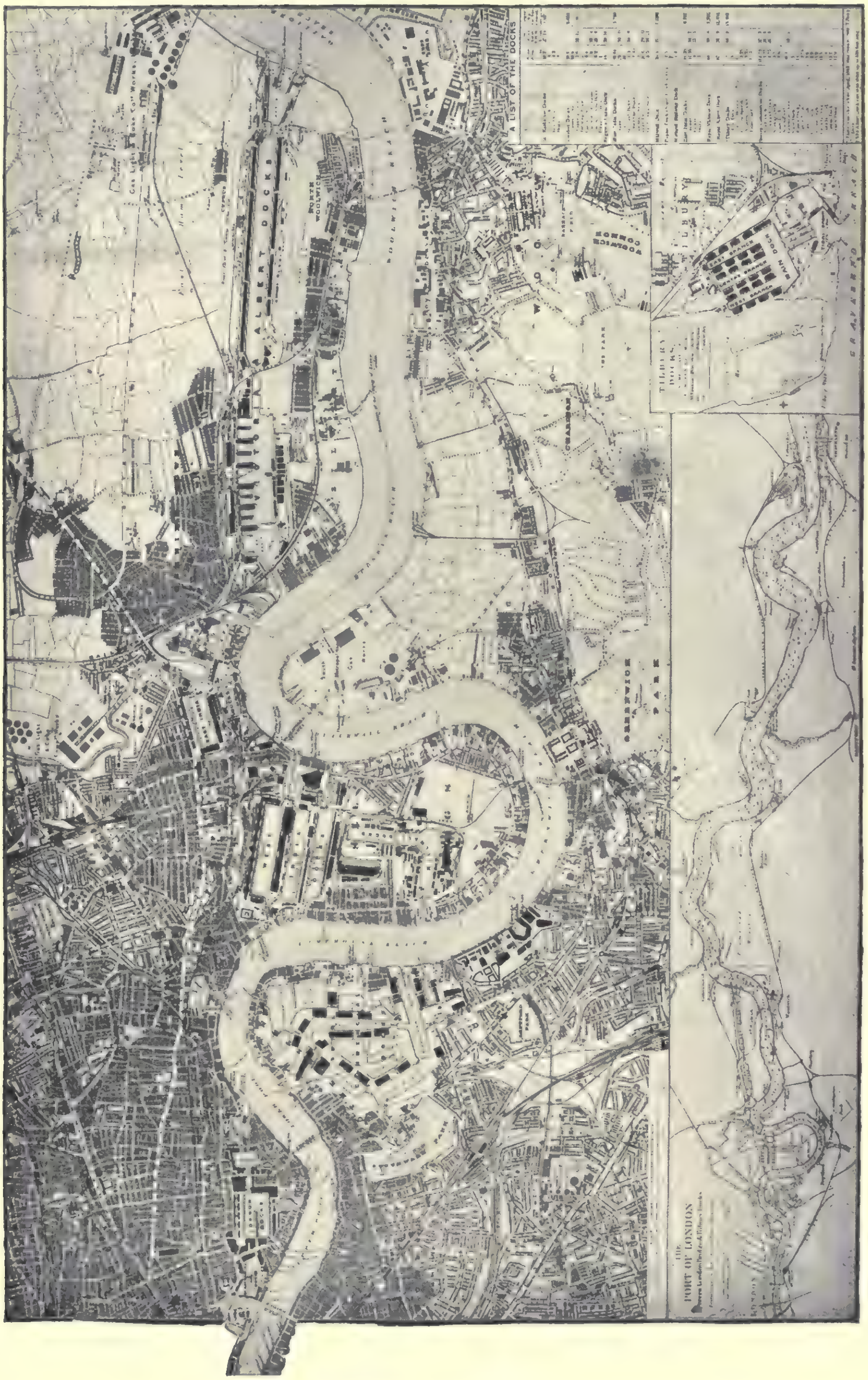
(From Report of Connecticut Rivers and Harbors Commission, 1916)

FIG. 4.—Plan of the "Free Port" of Hamburg A, B, C, D, E, F, G. Proposed extension of the "Free Port" A, G, H, I.



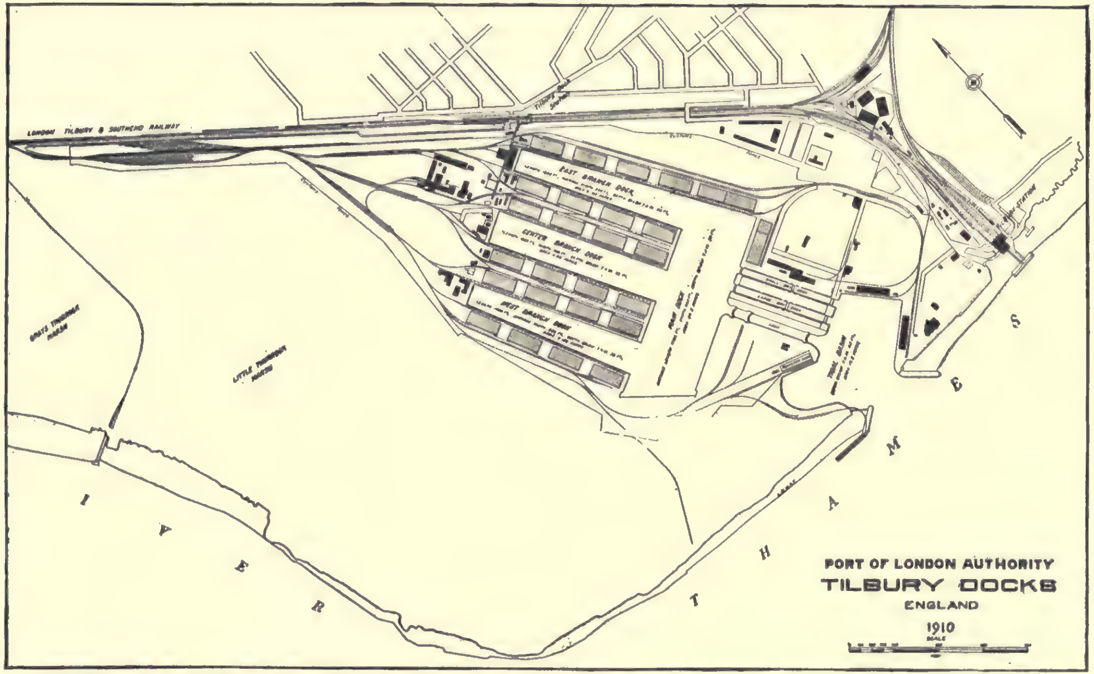
(From Report of Connecticut Rivers and Harbors Commission, 1910)

FIG. 5.—Present dock system of Antwerp shown in black near C. Present course of River Scheldt A, B, C, D. Proposed "Grande Coupure" (great cut) in river channel A, E, C. Proposed great extension of dock system shown to the right of new river channel C, E, A.



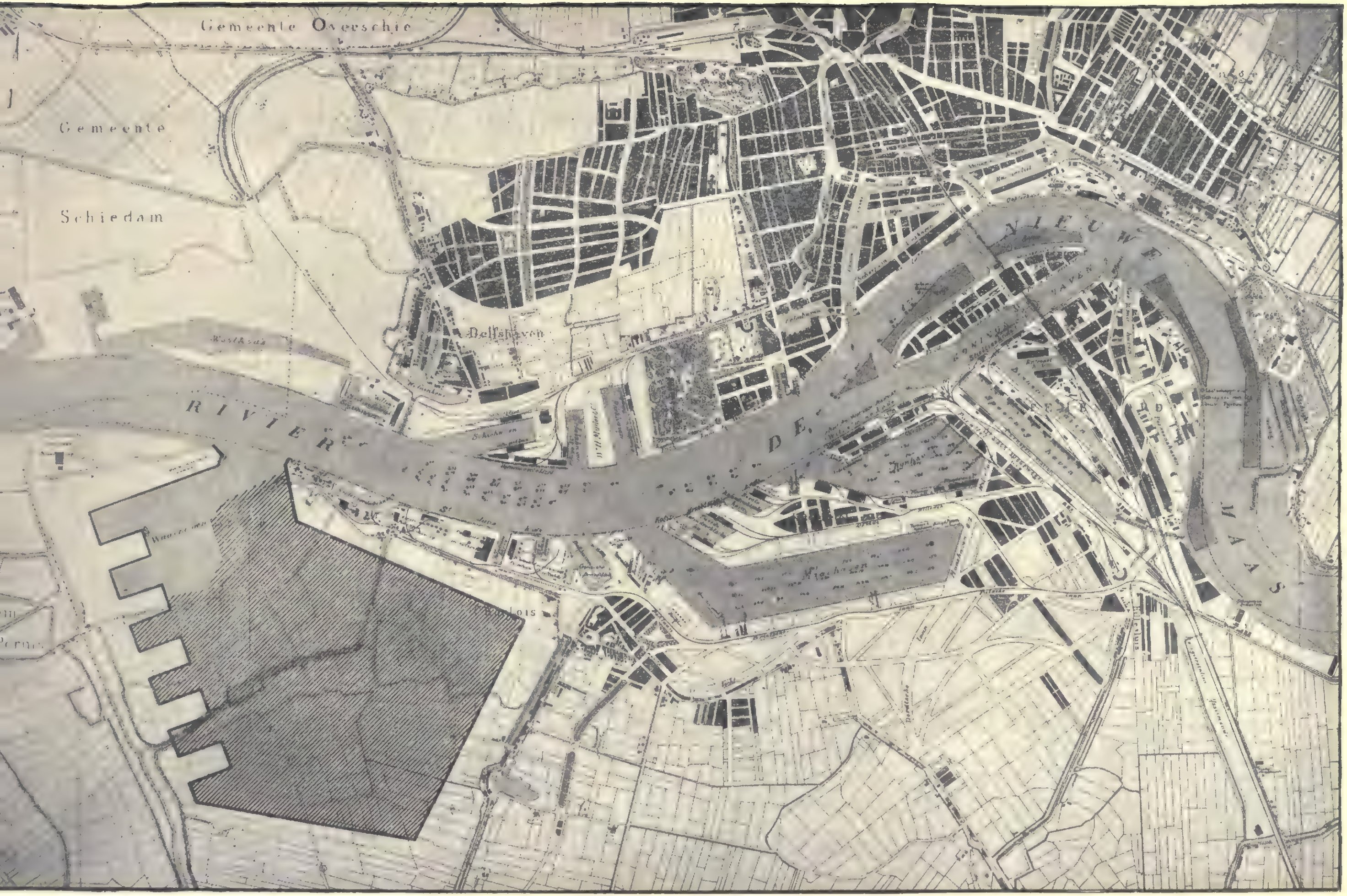
(From Report of Connecticut Rivers and Harbors Commission, 1910)

FIG. 6.—Plan of the Thames River and London docks.



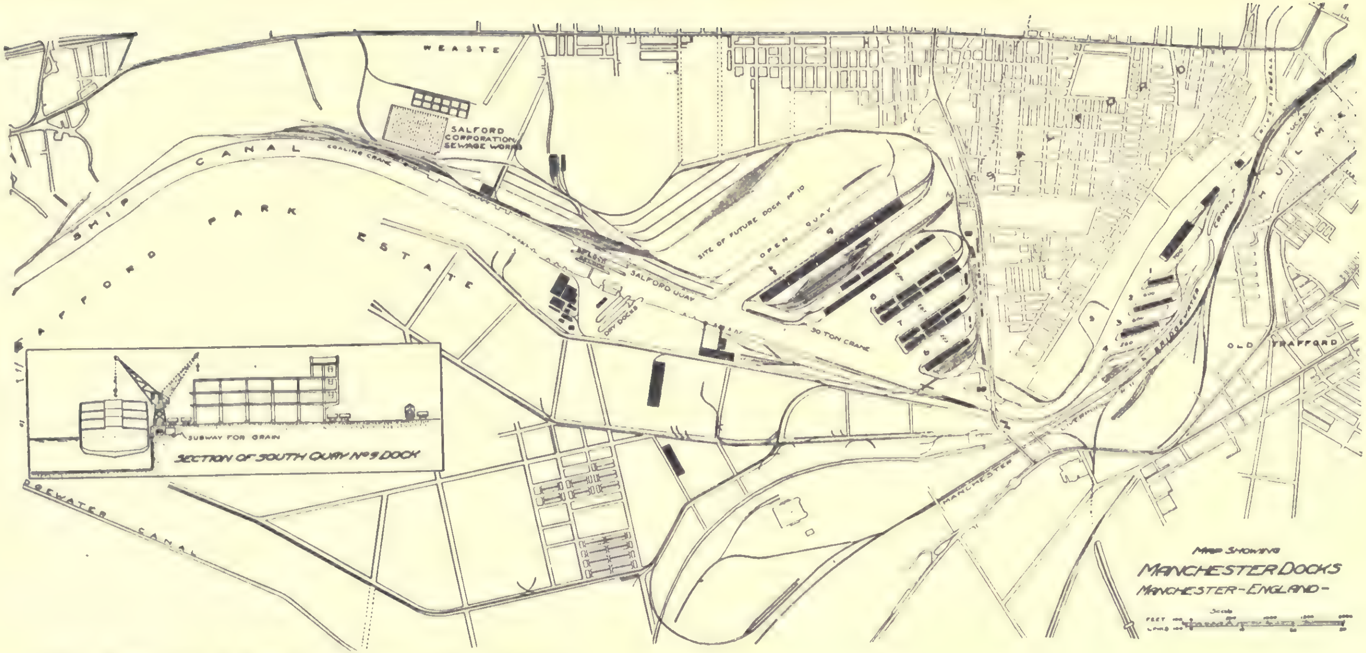
(From Report of N. Y. Barge Canal Terminal Commission, 1911)

Fig. 6*A*.—Tilbury docks.



(From Report of Connecticut Rivers and Harbors Commission, 1910)

7.—Plan of the port of Rotterdam. New "Waal" Harbor, area 800 acres, now being built is shown by cross-sectioned area in lower left hand corner.



(From Report of N. Y. Barge Canal Terminal Commission, 1911)

Fig. 8.—Map showing Manchester Docks, Manchester, England.

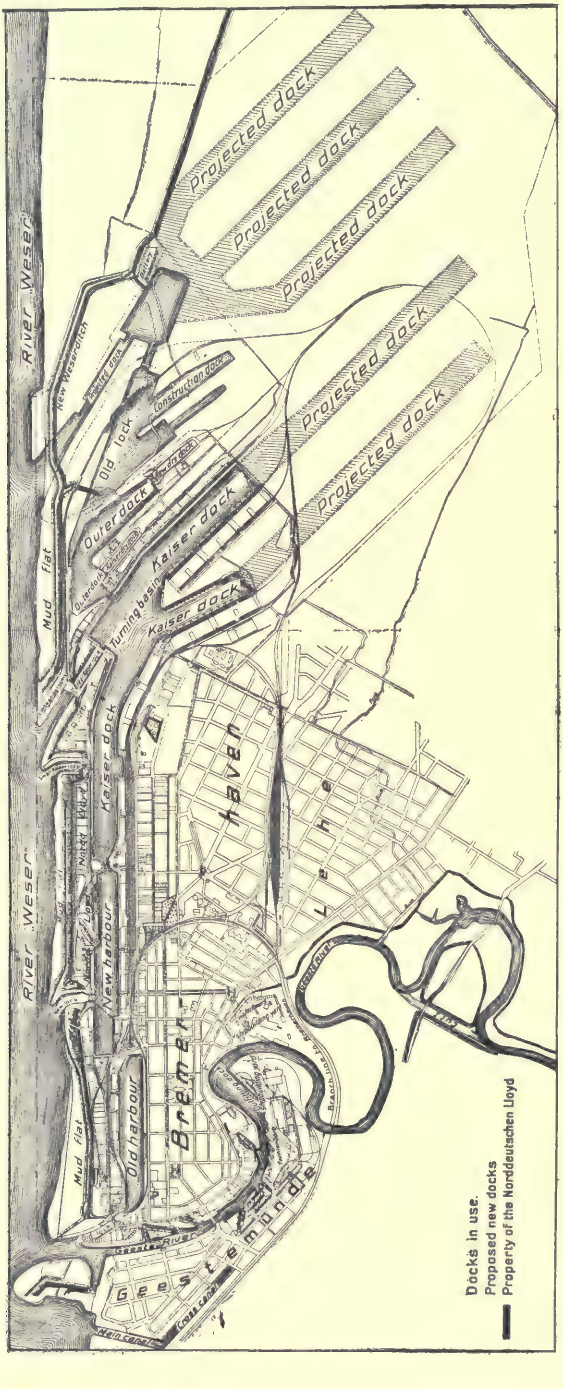


FIG. 9.—Bremerhaven.

harbor and the artificial basin. There is a tidal antechamber, or waiting basin, and locks through which a ship passes into the

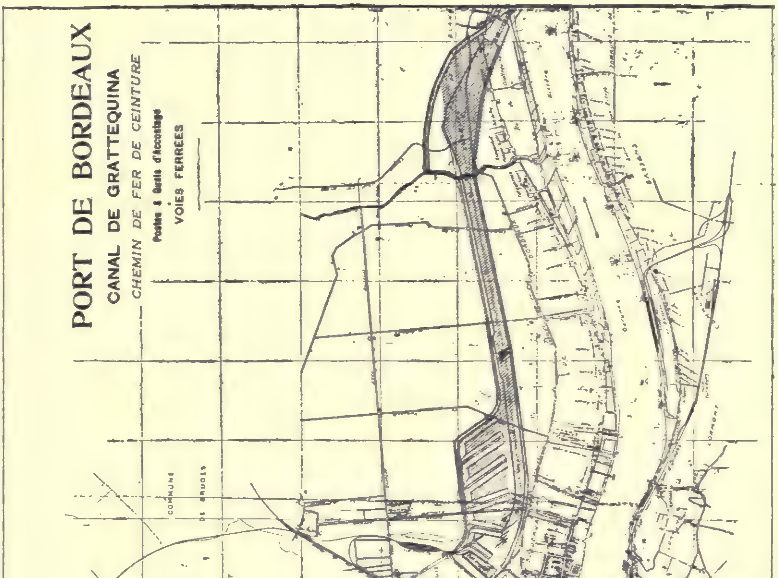


Fig. 10.—Port De Bordeaux.

constant-level-water of the dock. The dock consists of a turning basin and three ship basins 300 feet in width between two filled piers 1,600 feet long. These piers carry spur tracks at each edge and down the center, and four transit sheds on each quay. Back of the piers are the railway classification yards.

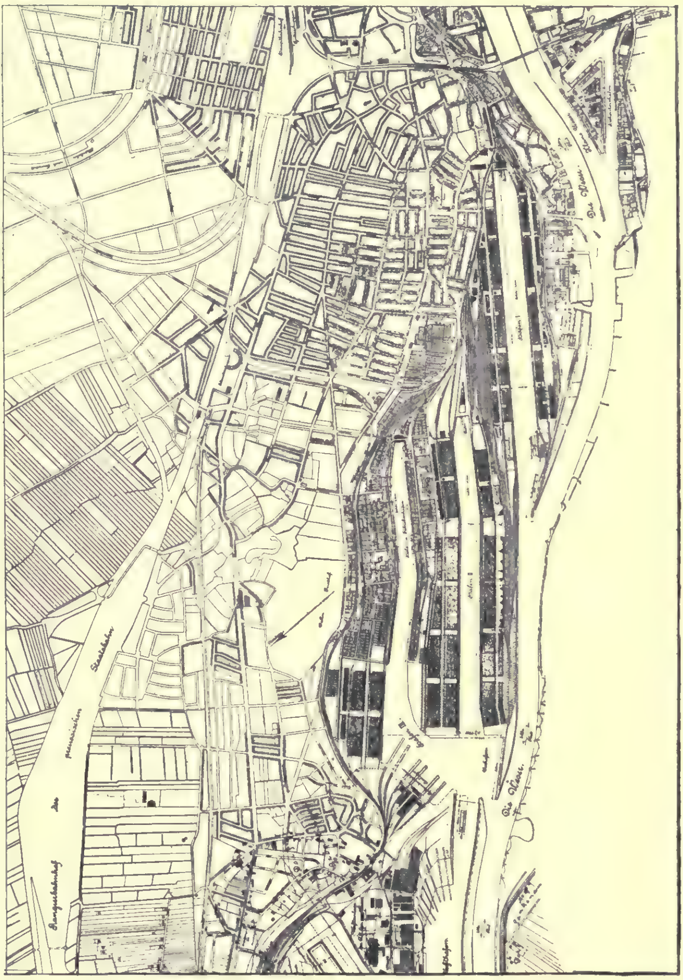


FIG. 11.—Bremen. Commercial Basins I, II and III and Shipyards (on left). Transit sheds occupy the face of the quays and warehouses just back of them.

It is unnecessary to go into further detail concerning the various types of ports. The outstanding differences are evident from the maps. Other differences of detail will be noted as occasion arises.

CHAPTER III

GENERAL CHARACTERISTICS OF A WELL-COÖRDINATED SEAPORT

Perhaps the best way to fix in our minds what a port should be in all its parts is to construct in outline an imaginary port. What we will discuss in brief now in order to have an outline will be taken up in detail later.

A port is the funnel for the passage of wares between lands across the seas and the interior of a country. Like the drainage basins of a river system, a port has as its hinterland an economic drainage basin for which it is the outlet. The size of the hinterland and, therefore, the importance of the port depend upon the nature of its physical connection with the hinterland. Cheapening and extending transportation will enlarge the area. There should be connection by rail and by water. Imagine a port situated on the estuary of a long, navigable river leading into a fertile country with well-developed agriculture and industry. Also suppose that various networks of railroads connect the port by land with a similar prosperous interior. What will be the demands made on such a port, and how must it be laid out in order to best serve the hinterland?

At the very beginning of the problem must be noted what may be called *the reservoir principle.* The system of transportation from an American factory to a foreign consumer is composed of many movements, each distinct yet each part of the whole. Transportation by rail, carts, piers, ships, etc., involves a series of distinct movements, each complete in itself. These separate movements can not be entirely synchronized. The result is that one movement does not keep pace with the others. Where the joint occurs there is either lost motion or congestion. It is like the internal combustion engine which develops power every fourth count and every second time the fly-wheel turns over. That is why there is a fly-wheel; to take up the power when it occurs and carry it over the dead centers. In a transportation system there is the same sort of intermittent motion along the routes. With the exception of belt and bucket conveyors and pipe lines there is no continuous movement, the ideal to which freight handling aspires. Therefore fly-wheels or reservoirs must be devised at the termini of each intermittent movement to take up the load and hold it until such time as it may be carried further. The smaller the number of the cylinders the larger the fly-wheel. The greater the irregularity of ships, freight trains, or canal barges entering the port, the more provision must be made for carrying the load over the dead centers. For instance the ore and coal stock piles at the steel works on the Great Lakes must carry over a five-month dead center of frozen navigation. Our eastern cities without such reservoirs can not exist five days without coal.

The two great reservoirs are the *warehouse* and the *transit shed.* A transit shed is the building on a wharf for the temporary storage of goods in transit between the ship and the railroads or warehouse. As subdivisions of these two units there are many minor points where reservoirs are necessary. One is the point of deposit of freight transferred from the hold of the ship to the wharf. Freight must not "hang" for lack of place to set it down. There are also points for loading carts, freight cars, barges, or lighters.

There is no blanket expedient, no panacea, no cure-all. Each point must be discovered in the particular system and each case solved on its own demerits.

The railroad problem in relation to port operation is very complex and at present is in a state of flux. Nevertheless there are certain fundamental principles which must be stated.

The first is that with equal facilities for handling and with equal port charges the port with the widest choice of transportation facilities to the interior will be the greatest port. These facilities include waterways as well as railways. The largest ports of Europe are the ports at the mouths of great navigable water systems, such as Rotterdam on the outlet of the Rhine and Meuse systems, and Hamburg on the Elbe-Oder system. Antwerp is the port for the Scheldt and Belgian-French Canal systems. Inland water navigation is important to the port. Yet even in the case of the highly developed German waterways two-thirds of all the tonnage travel by rail. A port will be great if there is a large choice of connections with the interior. There is no case of waterways vs. railways, but it is waterways *and* railways which make the port attractive to shipping. Many connecting lines act as the increase in the number of cylinders which makes a motor run smoothly.

If the port with the best prospects is the port with the most connection by rail and water with the interior, it follows that there must be equal, universal, and free movement between any pier and any railroad line. To this must be added universal connection with any warehouse, and free movement from any one part to any other part. A port must be a unit in respect to all its terminal facilities. Although it is still far from ideal, the reason that New York has grown beyond all other Atlantic ports is this universality of railroad connection. The complete harmony between every ship and every rail line is accomplished by so-called "free lighterage." Free lighterage is the lighterage service performed by the railroad as part of its service included in the freight rate, between the end of the tracks of the railroad and any part of the port of consignment. The advantage of the coördination has been so great that the expense of lighterage and the freight-rate differentials against the port have been offset by better service, and the port has prospered.

To reiterate, port planning involves the establishment of two main reservoirs, the pier shed and the warehouse, with a completely flexible universal connection between them and all vehicles by land and water. Keeping constantly in mind these two points, reservoirs and flexibility of physical connection, what are the freight movements at a seaport necessary to connect ocean and land transportation?

Freight Movement at a Port.—An analysis of the kinds of freight involved in marine terminals will show four distinct categories:

1. Passengers—First and second cabin, third class, steerage.
2. General cargo—Standardized package freight, bags, crates, bananas, etc.
3. Bulk cargo—Grain, ore, coal, petroleum.
4. General cargo—Miscellaneous package freight.

Obviously each group requires particular accommodations. It is not always possible to handle the various groups in specially designed quarters, but the greater the degree of the segregation the more it will be possible to design special labor-saving machinery and reduce the cost of handling.

(1) *Cabin Passengers.*—It is of far greater convenience for all concerned if cabin passengers can be landed at a passenger landing stage, as at the Princes Landing Stage, Liverpool, or at Cuxhaven, or at the Municipal Landing Stage at Hamburg, and at other notable ports such as Fishguard. As the time element is important it is desirable to have the stage accessible at all tides and with no difficulties in berthing the ship quickly. At Bolougne-sur-Mer, Cherbourg, and elsewhere the passengers are landed by lighter. This is inconvenient in bad weather. A permanent structure such as the passenger landing stage offers clean accommodation for the customs formalities and also quick rail or other connection with the hotels and the principal inland cities. The entire organization should give comfort and speed of movement.

Steerage Passengers.—In the case of third class and steerage passengers other quarters than for cabin passengers are necessary, but they should be no less sanitary, and dispatch is essential. The great emigration grounds at Hamburg are a modern example of a steerage passenger "storage reservoir" designed to meet the particular needs of this traffic. Steerage passengers are almost invariably lightered.

(2) *Standardized package freight* and (3) *Bulk cargo* lend themselves to mechanical equipment. This means that there should be basins for coal, others for ore, others for petroleum. The petroleum basin should be separated from the remainder of the harbor by water gates to prevent floating oil from endangering shipping in case of fire. Also grain elevators form a specialized section by themselves. Much bulk cargo may be handled directly from the side of the ship "in stream" where most of it moves by lighter or barge to the consignee or to the interior, as will be the case when the New York Barge Canal is in operation. This requires "in stream" mooring berths.

(4) *General cargo* is almost invariably transferred from hold to wharf to be spread out for sorting by marks and further disposition. Passenger and cargo liners with freight of high specific value seek the well-equipped quays. Tramps carrying bulk will seek the specialized equipment or the mooring posts.

Bearing in mind the four classes of freight the movements in a correctly planned port may be as follows:

I

From the *pier* the goods may move:

(*a*) To *railway car* to be switched to the

1. trunk line for the interior if in car load lots (C. L.);
2. transfer yard for consolidation if less than car load lots (L. C. L.);
3. warehouse with spur siding for storage;
4. industrial plant with spur siding for consumption.

(*b*) Or to *dray* for delivery to

1. local consignee not otherwise reached;
2. warehouse not otherwise reached.

(*c*) Or across the pier—if it is a narrow transfer pier as at New York—to be *lightered* to

1. warehouses with waterside delivery (lighter canal);
2. industrial plants, with waterside delivery.

Railroad freight should not be lightered except at ports where the belt line railway is an impossibility.

II

Overside at the pier the cargo may be loaded directly onto lighters

1. for movement to warehouses with waterside delivery;
2. to industrial plants with waterside delivery;
3. to barge canal terminals in broken lots, otherwise cargo overside may be loaded directly to canal barges.

III

Overside in Stream. Cargo ships berthed *in stream at mooring posts* will discharge overside

1. into barges for the interior;
2. into lighters and scows for local consignees having waterside delivery;
3. minority cargo (in the case of a ship carrying its main cargo in bulk and a small portion as package freight) to (*a*) warehouse, (*b*) railroad freight stations, (*c*) industries.

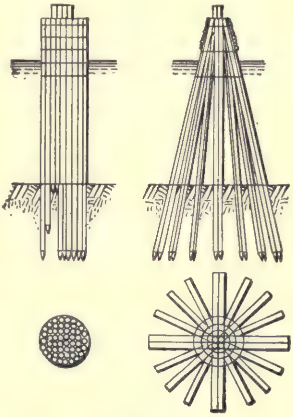


FIG. 11*A*.

Cargo ships carrying largely bulk cargo and some parcel freight, but enjoying the free wharfage afforded by the mooring posts for bulk cargo, will prefer to lighter the small proportion of package freight rather than pay wharfage on the entire ship.

In order to visualize the freedom of movement which a well-organized port should offer the diagram in Fig. 12 may be helpful. It will be seen that the various vessels and vehicles, in order of importance are: belt railway car, harbor lighter, and river barge. The dray should never be called into use except when there is no available switching or lightering service. Through railroad freight should always be switched. The diagram illustrates what is meant by free and universal flexibility of movement.

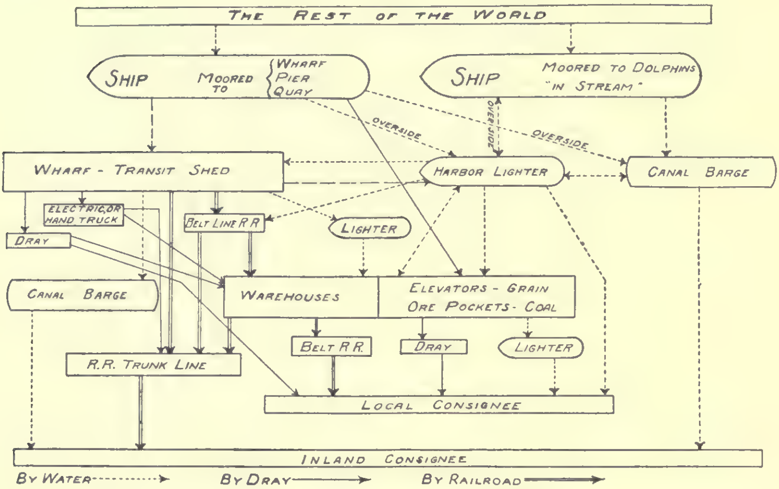


FIG. 12.—Port movement of inbound freight.

CHAPTER IV

PORT COMPETITION FOR RAIL AND MARITIME FREIGHT

Geographical Advantages.—Ports geographically widely separated compete with each other for maritime freight on the one hand and for domestic freight on the other. Each port endeavors to attract ships to it from its competitors and also seeks to attract interior freight to itself which might be routed through its rival. The successful port must gain both sea and land traffic or it can not act as the link between the two, which it is a port's business to do.

To take the example nearest at hand, the North Atlantic ports from Norfolk to Montreal compete for the traffic overseas from America and Canada. Even New York, New Orleans, and Montreal are competitors.

Some ports are more advantageously situated than others with regard to the nearness to Europe. Distances to Liverpool for example are:

From Boston	2,862 miles	————
From Montreal	2,972 miles	110 farther
From New York	3,056 miles	194 farther
From Philadelphia	3,199 miles	337 farther
From Baltimore	3,355 miles	493 farther

If other things were equal Boston would have the advantage of the short haul, and would capture the ocean shipping. But it is more economical to use the longer water haul if the railroad haul, which is more expensive per ton-mile, can be shortened thereby. As water transportation is more economical than rail or other land transportation, the shorter the rail haul and the longer the water haul over the entire distance from the point of origin to the point of destination, the greater the economic efficiency. In practice, however, it is the freight rate, not the distance, which makes the difference to the shipper. If the rail rates are the same from the West to Baltimore as they are to Boston, it is immaterial to the shipper through which port his freight is routed, provided, first, that the through rate to the final destination overseas is the same from each port; and second, that the service from one port is as frequent as from the other. Given equal land freight rates to both ports the ocean carrier would also be forced to make equal rates to both ports to compete with the other lines. In short, for competing ports the costs of land plus water hauls must be equal.

The advantage to the ship line of choosing the nearest port to Europe is notable. For instance in the case of Boston and Baltimore, the line making its port Boston will save 1,000 miles of steaming each round trip to and from Liverpool as compared to Baltimore. With five steamers a weekly service could be maintained between Boston and Liverpool which it would require six steamers to maintain between Baltimore and Liverpool. Ships running from New York to Liverpool could make only fourteen trips as compared with fifteen trips from Boston. Therefore, other things being equal, the port on the North Atlantic with the shortest course to Europe would be the first port. This is not Boston after all, but Halifax. It is on this principle that Halifax has based its hope of success as a port which has led to the expenditure of great sums in creating the most modern port equipment. It will be left to the coming discussion to decide if the premise assumed by Halifax, that the nearest port to Europe will have the competitive advantage over other North Atlantic ports, is sound, or if this factor is outweighed by other more important considerations.

The Load Factor.—The element of the greatest influence in the competition for ocean shipping between ports is the so-called load factor. By the load factor is meant the fact that the ship bringing a cargo to a port will get another cargo out. It is the port which can assure shipping a full cargo both ways which must win. It has been pointed out that the ocean freight rates to England are greatly influenced by the fact that cargo boats can usually get a cargo of coal out if there is no other freight available. An interesting investigation[1] showed that formerly the freight rates both ways between England and the Argentine, when added together, remained about 26 shillings, although during the wheat season the rates on wheat from Argentine were high. It was necessary for shipping to move the Argentine wheat, but rather than go out to Argentine in ballast it was advantageous to load coal even at a low rate. However, this coal at a low rate made it possible to quote lower rates on wheat from Argentine than would otherwise have been possible without the coal cargo out.

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[1] Dr. Erich Zimmermann, *Modern Business*, June, 1917.

In the case of Montreal an investigation[1] shows that although 93% of all the imports into Canada, and in addition a great amount of imports for the United States, pass through Montreal, yet this entire tonnage in does not amount to 50% of all the tonnage out from Montreal. In other words Montreal and its hinterland do not take enough cargo to more than half fill all the ships which come to the port to load Canadian products out. The passenger load inbound may make the half filled inbound ships somewhat more profitable, yet the one sided movement makes the total round trip earnings of the ships to Montreal too low to attract more shipping. The result has been that although there was enough wheat to fill many more ships from Montreal, more than two-thirds of Canadian wheat was shipped through United States ports. The United States ports were able to assure full cargoes both ways because of the greater development and purchasing power of the more developed hinterland of the United States. It would seem that shipping along the North Atlantic range has grown up subject to the load factor. Ports have attracted shipping according to their ability to assure full cargoes both ways. Canadian and American wheat has been the great leveller, flowing through that port which offered both regular tonnage and distress room at the moment.

Investigation of this problem, as is the case with many other points in the science of ports, has not been thorough. It is evident that the statistics we need to ascertain and to study concern the relation of loading in to loading out. The port which finds that there are many ships arriving or leaving in ballast, without cargo, is badly off. This condition is not compatible with the healthy development of the port, and everything which it is possible to do to bring the balance of the load factor back to normal must be done.

In the last analysis the secret of the load factor is to be found in the conditions of the hinterland and the transportation facilities connected with it. All the handsome piers and deep channels which money and engineering skill can create will not bring ships to the port unless the hinterland can supply a cargo out and at the same time absorb a cargo in.

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[1] SANFORD EVENS, *Annual Report of the Harbour Commissioners of the Port of Montreal for* 1916, p. 140.

The all-important condition for the development of a favorable load factor is the railroad net with its rate structure. At the same time the railroad problem is the most elusive and the least conspicuous item of port study.

Grain Exports and Freight Rate Structure.—Western grain for export to populous Europe was the chief commodity hauled by the early American railways. In fact, the railways were built largely to develop the great wheat areas. As late as 1881 wheat composed 73% of all the eastbound freight carried to Baltimore, Philadelphia, Boston, and New York.

In regard to their connections with the railroads, the ports of the Atlantic seaboard fall into two classes. There is New York, which has many railroad connections with the interior, and there are all the other Atlantic ports, which were originally each served by its own railroad.

Thus the Baltimore and Ohio R. R. chose Baltimore as its port and developed it. In the same manner the Pennsylvania R. R. developed Philadelphia. So also, the Norfolk and Western R. R. serves Norfolk, and the Chesapeake and Ohio serves Newport News. Boston has been built up by the Boston and Maine and the Boston and Albany R. R's. Now there is a third road, the New York, New Haven and Hartford, which enters Boston.

The connection between the interests of the railroad and the development of the port is obvious. For if grain and flour could not be exported via Baltimore, the Baltimore and Ohio R. R. could not haul them. If they could not be exported via Philadelphia the Pennsylvania R. R. would not have them to haul. Therefore the various railroads waged continued rate wars for the hauling to their respective ports of this controlling export traffic.

Thus all these ports were once one-railroad ports. Later the Pennsylvania R. R. gained access to Baltimore, and the Baltimore and Ohio R. R. to Philadelphia. But all the railroads had to come to New York, because by the time the railroads had grown to be a vital factor in the country's commerce, New York had become the chief transshipping center. At all the other ports on the Atlantic coast, each railroad does what it can to develop its own terminal port. At New York they all participate in the development of an already established port.

There are good reasons why this should be so. New York firmly established its supremacy as premier port and commercial center when the Erie Canal was built in 1825, and thus developed a great hinterland which was not open to its competitors, Boston, Philadelphia, and Baltimore. The Erie Canal brought the cargoes to New York with which to fill the ships. When the railroads were built they had to come to New York to meet the increased amount of shipping caused by the Erie Canal through the operation of the load factor. Furthermore, during the open season for navigation, which lasts about seven months throughout the year, they had to meet the competition of the Erie Canal.

Particularly was this shown in the fluctuations of the grain rates from Chicago to New York, prior to 1877. In 1869 about 77% of the grain coming from west of Chicago moved by the canal. In 1876 about 56 per cent. of the grain took that route. Railroad rates therefore fluctuated according to the amount of grain carried by the Erie Canal. Here are the figures for the year 1873:

January[1]	$1.50 per ton (of 2,000 lbs.)
April	1.40
May 1	1.50
July 10 to end of July	0.80, 0.75, 0.65
Mid-August	0.50
September	1.00, 1.25
Close of Navigation	1.60, 1.80

In order to develop its business by hauling freight for oversea commerce the railroad formerly controlled a line of steamers running from its terminus port. The American Line was a Pennsylvania R. R. property. The Johnston Line from Baltimore to Liverpool was originally the water continuation of the Baltimore and Ohio. The Canadian Pacific R. R. in 1903 bought fifteen steamers from the Elder Demster Line and laid the foundation for one of the largest steamship lines of to-day. The Northern Pacific owned and operated a fleet on the Pacific.

Few American railroads own transatlantic shipping. If the railroad does not own its line of ships it attracts a line to its terminus by offering free piers and wharfage. This means a saving of pier rentals of $50,000 to $80,000 a year as against New York. The railroad also often guarantees to a line of ships agreeing to serve its port all the freight that the railroad can collect from its territory.

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[1] Evidence of Mr. Lincoln, of the Merchants Association before the Interstate Commerce Commission in the New Jersey Lighterage Case, February, 1917.

In the early days of railroading the competition among the roads to capture freight for their respective seaports, together with the competition of the Erie Canal, led to long and disastrous rate wars. Rate wars are ruinous, and the natural result was an agreement among the railroads to divide the traffic that all might earn a living rate. In 1877 an agreement was reached which established the rate structure that is still in large measure effective. The merchants of the competing seaports were not satisfied because the agreement carried the so-called differentials by which Baltimore was allowed a rate three cents per 100 lb., and Philadelphia two cents per 100 lb., under that of New York. The New York Central was prevailed upon in 1880 to withdraw from the agreement. This act precipitated the last and worst of the rate wars which extended over a year.

Thereupon an arbitration commission of eminent men was formed. "This Arbitration Commission rendered its decision in 1882. The decision was accepted and has been the basis of relative rates ever since. The rate differences of 1877 were re-affirmed; namely, Baltimore three cents and Philadelphia two cents per 100 lb. under New York. Boston was to continue its practice of carrying New York export rates.

"It was declared by the commission that lower rates to Philadelphia and Baltimore were justified on the 'cost and distance' principle; that is, they were nearer to the West and it cost less to transport freight between these more southern ports and the interior. But the leading justification was on the principle of competition. The Arbitration Commission said that through rates from Chicago to Liverpool, for instance, could not be higher from Baltimore and Philadelphia than from New York and Boston, otherwise no traffic would move via the southern ports. It was found that the average ocean rates from Philadelphia and Baltimore were higher by two cents and three cents per 100 lb. respectively than from Boston and New York. That justified a lower inland rate of three cents to Baltimore and two cents to Philadelphia, in order to make the through rates the same. Baltimore and Philadelphia then had natural approaches to the sea of considerable less depth than New York and Boston. In 1882 these natural differences had not been eliminated by government expenditure to the same extent as to-day. Tramp steamers carrying full cargoes handled the grain traffic in 1882. Because of the limited depth of the approaches to Baltimore they charged about three cents per 100 lb. more for taking a cargo of grain from that port abroad than they charged for taking a cargo from New York or Boston." The same reasons applied to the two-cent rate of Philadelphia.[1]

These rates went unchallenged until 1898. In the meantime New Orleans and Newport News were developed as competitors and also the Interstate Commerce Commission was formed to protect the public from unjust rates. In 1898 the differentials were contested and the I. C. C. reaffirmed the differentials; that preference was based on (1) distance, (2) cost of transportation, and (3) exigencies of competition.

But by this time the differences in the charter rates from the various North Atlantic ports had changed, and now the charter rates were found to be the same from the entire North Atlantic range. However, the "berth rates" for parcel lots were less out of New York. There has been a steady shifting to the line traffic of grain shipments and to-day most of the grain is carried by liners and not by tramps.

It was stated by the Commission that the differential should be abolished in the case of grain shipped in full cargoes (charter-tramps). As it is not possible to distinguish grain in this manner the compromise was to cut all grain rates in half.

In 1904 the steel differentials were likewise cut in two. In 1905 and again in 1912 there were modification by the I. C. C. in the rate structure.

The rates of ex-lake wheat for export, *i.e.*, by boat from the North West and trans-shipment to railway at Buffalo, in the summer of 1914 stood:

Buffalo to Baltimore..................	5.2 cts. per bushel.
Buffalo to Philadelphia................	5.3 cts. per bushel.
Buffalo to New York..................	5.5 cts. per bushel.
Buffalo to Boston.....................	5.5 cts. per bushel.

Since then there has been a sharp advance. The differentials, however, are as much in evidence as ever, as the following tables will show.

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[1] Clapp, "Port of Boston," Ch. VI.

RATES IN CENTS PER BUSHEL ON WHEAT, EX-LAKE, APPLYING "AT AND EAST" OF BUFFALO (November, 1917)

To	Domestic	Export
New York	7.0	6.8
Philadelphia	7.0	6.5
Baltimore	7.0	6.5
Boston	8.6	6.8

RESHIPPING RATES IN CENTS PER 100 POUNDS FROM CHICAGO (Jan., 1918)

To	Domestic		Export	
	Grain	Grain products	Grain	Grain products
New York	16.8	17.5	15.3	17.5
Philadelphia	14.8	15.5	14.3	15.5
Baltimore	13.8	14.5	13.8	14.5

Rates have been made for years on the basis of 75 cents from Chicago to New York or a percentage thereof. There has been a recent sharp advance in this rate. The differentials, however, continue to be visible.

CLASS RATES BETWEEN NEW YORK AND CHICAGO

	1	2	3	4	5	6
Effective Jan. 20, 1915	78.5	68.3	52.5	36.8	31.5	26.3
Effective July 15, 1917	90.0	79.0	60.0	42.0	36.0	30.0

Canadian Ports in Competition with New York and other American Ports.—The decrease in exports of American grain and flour is changing the entire shipping and port situation. The marked decline in American grain for export is being replaced to a large extent by increased production of Canadian wheat. To capture this freight means sharp competition between American and Canadian ports.[1]

Competition with Canadian ports has been successful. The wheat shipped from the Head of the Lakes for twelve months ending July 31, 1916, amounted to 312,000,000 bushels. Of this 181,000,000 bushels went through United States ports. Bearing on this situation of Canadian wheat we may note the following facts.

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[1] FREDERICK WILLIAM COWIE, Chief Engineer, Harbour Commissioners of Montreal.

There has been a great increase in wheat production in Canada due to the cultivation of hardy varieties of wheat. Great Lake navigation has been an increasingly important factor in marketing it. Canada's coast on the Great Lakes is 1,500 miles with 35 harbors. The St. Lawrence type of Lake steamer holds 2,500 tons with 14-foot draft. Some steam barges are as large as 14,000 tons.

The distance from the Head of the Lakes to the Atlantic coast is 1,000 miles. The Head of the Lakes is within 300 miles of the center of Canada.

Canadian Western railways on the Head of the Lakes, making the lake ports of Port Arthur and Fort William great traffic funnels. There are several possibilities of shipment and that is where the competition comes in. They are: by water route to Montreal, by Lake and railroad via Canadian Lake ports, by full sized Lake vessels to Port Colborne, by full sized Lake vessels to American Lake ports.

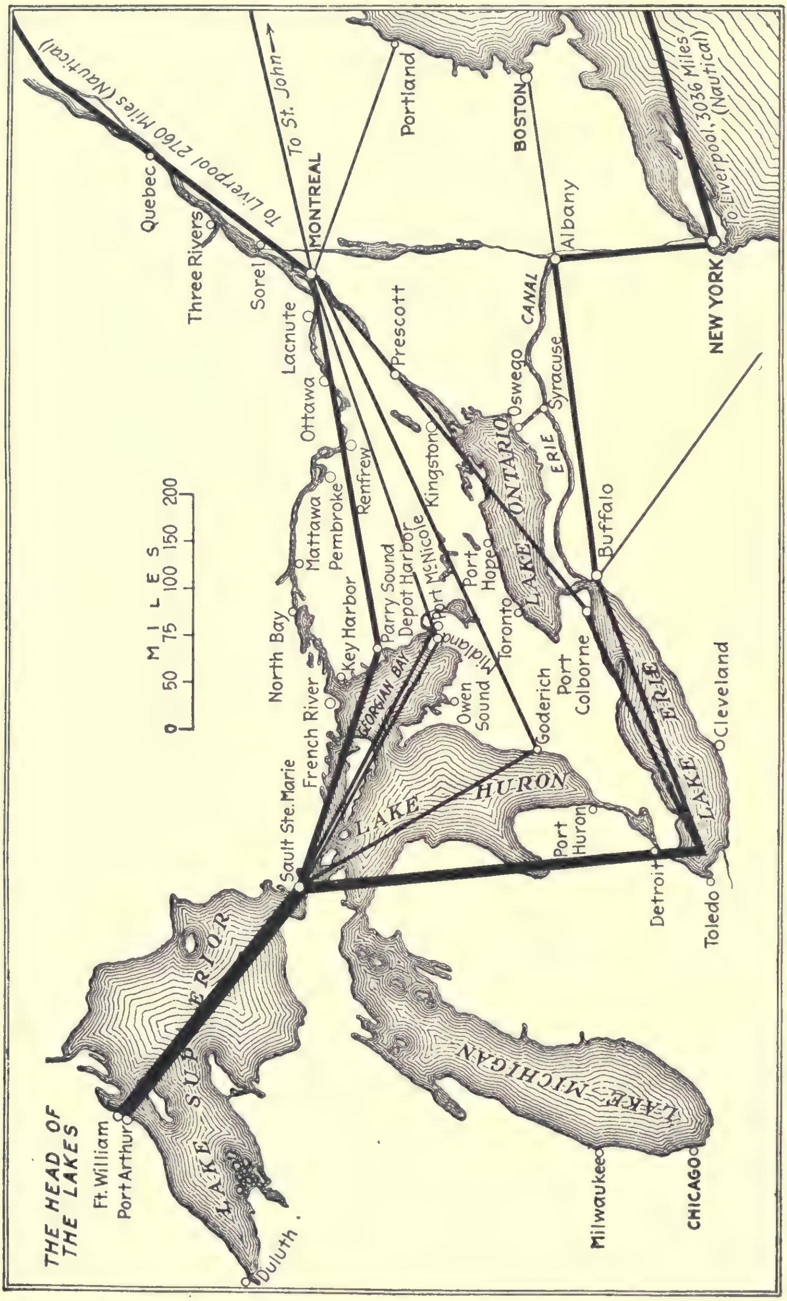
The advantage of the situation of Port Arthur and Fort William as funnels for the Lake-railroad commerce of the Canadian Northwest is reflected in the rapid increase in the population of the twin cities.

	1901	1916
Fort William	3,633	20,854
Port Arthur	3,214	12,500

To furnish the proper reservoirs for the golden flood there are 24 elevators with a total storing and moving capacity of

	Bushel	In, per hour	Out, per hour
Fort William	29,375,000	140,000	640,000
Port Arthur	15,550,000	90,500	449,000

The great importance to American port development of the grain movement from the Head of the Lakes through the competing Canadian and United States ports makes an understanding of this movement necessary. With the aid of the graphic map, Fig. 13, the essential movements are seen to be via several Lake



(From Annual Report of the Montreal Harbor Comm., 1916)
FIG. 13.—Canadian ports. Grain routes from the head of the lakes.

TABLE SHOWING TOTAL GRAIN EXPORTS (IN BUSHELS)
UNITED STATES & CANADIAN PORTS & DIVISIONS & GRAIN IMPORTED AT N. Y.

	Boston	New York	Philadelphia	Baltimore	Virginia	Mobile	New Orleans	Galveston	San Francisco
1915	7,644,157	83,439,278	31,031,107	90,018,600	40,201,289	1,344,416	53,855,509	50,749,427	18,677,944
1914	4,515,673	24,046,326	7,748,700	14,817,542	633,400	958,296	13,964,082	10,057,579	1,625,639
1913	6,856,358	41,906,509	10,184,556	41,664,560	16,535,044	1,308,532	19,015,891	13,213,697	5,030,235
1912	4,796,837	15,306,434	3,777,991	16,048,200	714,814	1,149,538	4,563,080	221,856	1,979,606
1911	5,809,985	14,728,285	7,500,885	14,117,105	1,792,693	1,513,248	7,841,362	416,411	9,725,006
1910	3,451,821	16,504,098	5,366,991	11,197,637	1,065,319	1,245,279	8,621,447	4,663,616	3,382,230
1909	2,990,072	23,849,707	12,203,122	13,228,113	1,859,983	857,254	7,983,730	14,418,466	5,207,783
1908	7,806,238	34,289,080	15,476,052	23,911,014	1,584,279	1,119,319	9,929,907	14,103,507	3,636,728
1907	7,640,626	43,172,902	14,841,049	25,326,102	3,416,245	2,541,299	14,349,098	19,956,715	7,018,547
1906	10,745,129	50,929,400	22,851,160	34,944,336	15,813,090	2,199,688	25,521,305	17,796,706	2,656,961
1905	9,070,155	26,109,903	6,276,926	10,006,272	4,062,256	1,397,729	18,934,580	5,907,351	5,111,191
1904	5,645,304	18,017,617	8,764,139	14,539,309	2,115,604	759,546	11,474,409	20,860,637	9,821,073
1903	11,730,452	35,829,568	14,193,401	25,652,183	7,800,544	436,940	32,492,021	20,667,561	15,197,251
1902	15,770,469	36,524,556	16,038,375	22,750,822	8,865,756	715,649	21,825,251	9,937,025	24,309,091
1901	38,038,480	79,963,453	39,861,266	54,461,068	15,260,982	2,049,979	38,512,699	14,010,478	17,702,337
1900	30,465,305	87,506,919	49,490,959	58,059,269	28,010,185	1,759,022	38,647,516	21,658,496	19,181,495
1899	34,316,323	96,324,825	36,819,329	60,779,228	22,047,671	....	27,392,902	17,722,539	....
1898	27,313,134	132,022,477	40,047,195	77,308,677	36,691,674	....	42,607,407	15,446,649	....
1897	23,699,752	81,136,865	24,178,509	57,680,356	31,032,267	....	34,385,770	9,576,084	....
1896	12,173,863	53,975,406	8,070,353	21,348,669	18,397,670	....	20,941,134	4,910,582	....
1895	7,178,681	28,566,447	5,204,714	12,523,964	8,446,752	....	4,446,584	68,262	....
1894	11,053,962	50,330,890	8,641,084	23,025,228	8,525,917	....	14,971,760	414,824	....
1893	7,407,308	54,571,569	13,669,008	21,224,270	4,227,580	....	18,642,554	1,370,898	....
1892	9,765,255	94,862,983	29,572,369	41,896,518	9,740,827	....	24,059,675	849,045	....
1891	3,241,426	26,233,654	2,897,297	8,143,582	1,607,873	....	5,409,949	2,130	....
1890	7,561,188	54,716,952	18,589,248	30,261,243	2,183,893	....	17,624,685	36,103	....
Total 1890–1915	326,687,953	1,304,866,103	453,295,785	824,933,867	292,633,207	....	538,014,307	289,036,644	....
Yearly Average '90–'15	12,564,921	50,187,158	17,434,453	31,728,226	11,255,123	....	20,692,858	11,116,794	....
% Total U. S.	6.1	24.5	8.5	15.5	5.5	....	10.1	5.4	....
Total 1900–1915	172,977,061	632,124,035	265,606,679	470,742,132	149,731,483	21,355,734	327,531,887	238,639,528	150,263,117
Yearly Average '00–'15	10,811,067	39,507,756	16,600,417	29,421,383	9,358,218	1,334,733	20,470,743	14,914,970	9,391,445
% Total U. S	5.7	20.7	8.17	15.5	4.9	0.7	10.7	7.8	4.9
Total 1910–1915	33,074,831	195,930,930	65,610,230	187,863,644	60,942,559	7,519,309	107,861,371	79,322,586	40,420,660
Yearly Average '10–'15	5,512,472	32,655,155	10,935,038	31,310,607	10,157,093	1,253,218	17,976,895	13,220,431	6,736,777
% Total U. S.	3.2	19.2	6.4	18.4	6.0	0.7	10.6	7.8	4.0

	Puget Sound, (Wash.)	Willamette	Chicago	Duluth & Superior	Michigan	Exported by Canada not product of	Total Canada, grain exports	Total U. S. grain exports
1915	10,298,619	14,953,992	24,540,647	4,228,256	6,018,495	37,545,495	133,787,126	444,951,428
1914	6,233,982	9,781,960	7,564,894	6,111,501	3,237,888	6,811,136	175,582,799	112,502,840
1913	5,884,309	10,055,050	3,170,115	7,023,942	6,499,353	9,636,131	120,007,963	199,788,130
1912	3,831,987	6,829,943	4,247,564	1,117,293	6,246,533	11,302,951	86,832,171	73,961,480
1911	4,391,179	7,345,881	6,692,186	3,080,212	6,546,356	8,421,536	61,759,331	98,937,864
1910	5,606,059	6,216,259	5,033,781	7,433,195	4,046,227	11,222,672	67,445,141	89,806,116
1909	5,619,265	7,172,731	3,030,675	6,362,180	2,979,329	....	69,579,659	12,326,630
1908	15,483,178	14,206,887	4,582,678	6,568,884	4,127,515	....	63,230,375	160,860,642
1907	6,716,940	7,198,844	5,330,076	....	....	5,819,879	37,400,032	173,071,899
1906	9,126,269	5,973,883	4,598,558	....	....	....	54,380,634	218,798,284
1905	3,283,281	2,641,350	4,996,798	....	....	....	25,836,117	109,660,410
1904	3,474,021	4,797,849	3,051,916	....	....	12,063,324	35,231,905	112,920,589
1903	10,222,774	9,882,819	6,744,383	....	....	8,970,233	51,351,263	207,598,291
1902	14,665,138	13,864,596	5,667,511	....	....	13,377,665	45,899,898	203,595,539
1901	10,055,142	13,752,602	15,277,220	....	....	23,969,647	45,368,232	355,769,073
1900	4,015,639	9,744,657	9,836,507	....	....	18,991,791	45,673,231	379,112,364
1899	....	....	....	....	....	24,596,551	46,256,871	357,756,155
1898	....	....	....	....	....	21,554,258	51,962,379	452,885,140
1897	....	....	....	....	....	13,428,852	30,411,032	321,842,795
1896	....	....	....	....	....	5,873,094	18,016,292	182,324,302
1895	....	....	....	....	....	4,664,044	16,567,934	105,937,009
1894	....	....	....	....	....	15,972,125	29,235,362	164,940,564
1893	....	....	....	....	....	6,819,906	26,062,860	170,051,351
1892	....	....	....	....	....	9,397,523	29,950,419	256,998,669
1891	....	....	....	....	....	6,110,255	13,711,511	88,158,972
1890	....	....	....	....	....	8,940,146	20,533,320	173,719,948
Total 1890–1915	....	....	....	....	....	285,489,214	1,402,073,857	5,328,276,484
Yearly Average '90–'15	....	....	....	....	....	12,976,782	53.925,917	204,933,711
% Total U. S.	....	....	....	....	....			
Total 1900–1915	118,907,782	144,419,303	114,365,509	....	....	168,132,460	1,119,365,877	3,053,661,579
Yearly Average '00–'15	7,431,736	9,026,206	7,147,844	....	....	14,011,038	69,960,367	190.853,849
% Total U. S.	3.9	4.7	3.8					
Total 1910–1915	36,247,135	55,183,085	51,249,187	28,994,399	32,594,852	84,939,921	645,414,531	1,019,947,858
Yearly Average '10–'15	6,041,189	9,197,161	8,541,531	4,832,399	5,432,475	14,156,653	107,569,088	169,991,309
% Total U. S.	3.6	5.4	5.0	2.8	3.2			

ports. The rapidity of the growth of the Head of the Lakes (Point Arthur and Fort William) is astonishing when it is considered that in the year 1900–1901, 6,500,000 bushels were handled, and in 1915–1916, 335,000,000 bushels.

THE GEORGIAN BAY PORTS

Depot Harbor.—The shortest route from the Head of the Lakes to tide water is by vessel to a port on the east shore of Georgian Bay. The first man to see the economic advantage to Canada in the "Lake and rail" route was Mr. John R. Booth, a lumberman of Ottawa. He built a railroad from Depot Harbor at Perry Sound through Ottawa to Coteau near Montreal. This road is now owned by the Grand Trunk R. R. This is the shortest route from the Northwest to a seaport, but there are heavy grades which are a great disadvantage for solid grain trains.

Midland Harbor (Tiffin).—To avoid the grades of the Perry Sound—Coteau line the Grand Trunk R. R. has built a new route with lower grades from Midland, on Midland Bay, the most easterly indentation on Georgian Bay. This is a very excellent lake harbor, well protected, with 25 feet of water. It is a one-railroad port for the Grand Trunk. It has extensive and growing industries and four large grain elevators with from 1,000,000 bushels to 2,500,000 bushels capacity, each of which has facilities for handling 10,000 bushels per hour. During the year ending July 31, 1916, nearly 30,000,000 bushels of grain passed through this port. There are new and modern terminal facilities at Tiffin, a nearby suburb of Midland.

Port McNicoll Harbor is only 2¾ miles from the Midland Harbor Terminals. This is the development of the Canadian Pacific Railway to serve as the link in its Lake-rail grain route to Montreal. Berthing space is provided for about eleven vessels. The latest works are a 3,000-foot pier 650 feet wide. During the year 1915–1916, 34,300,000 bushels of wheat passed over this route.

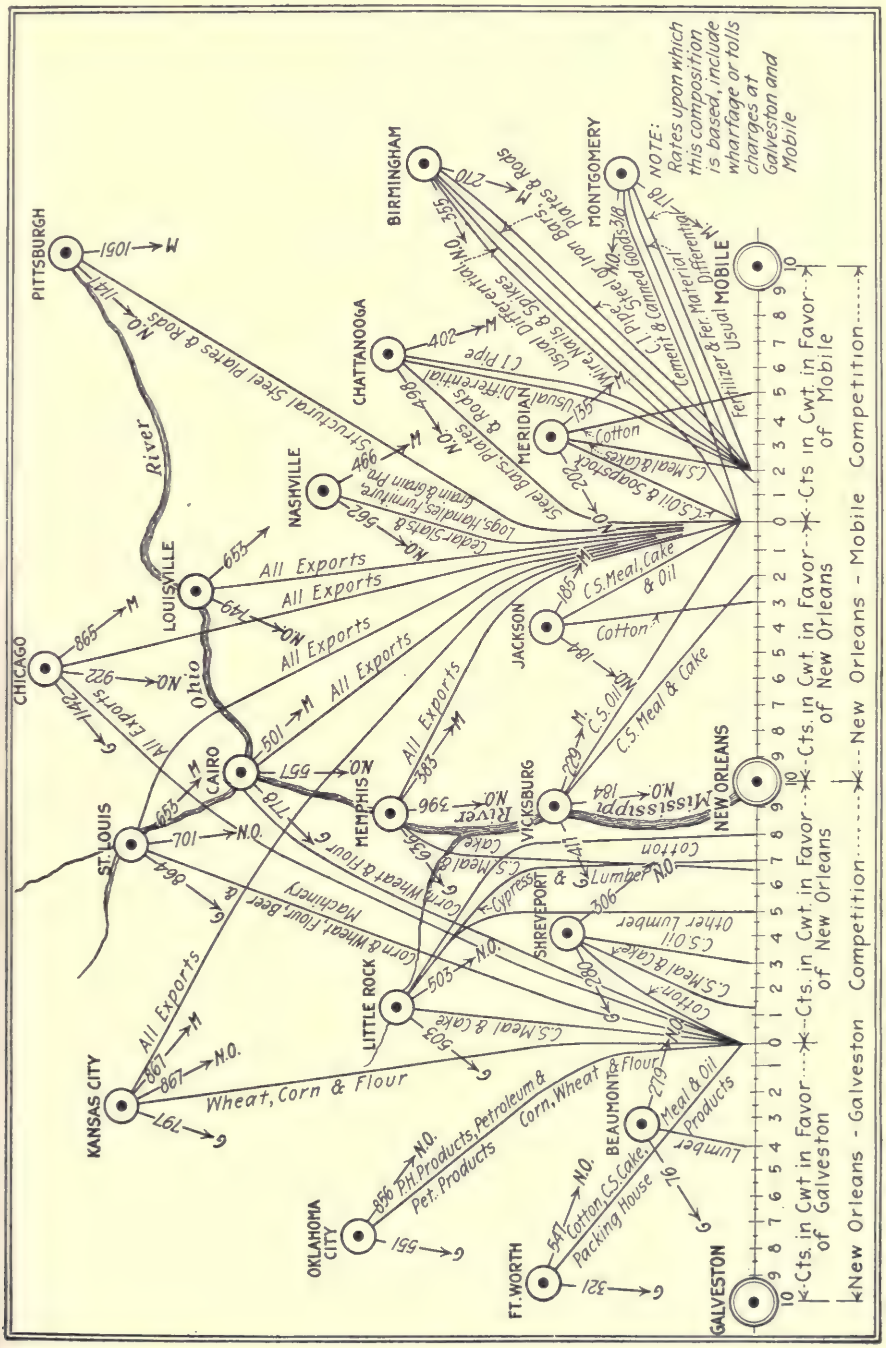
It is planned to increase the storing facilities of these ports as rapidly as possible in order to rush grain by water to this point while navigation is open, and then move it on by rail at leisure during the winter. At present the facilities provide for the receipt, storing, and transshipping by rail of 300,000 bushels to 400,000 bushels of grain per day at each of these two railway terminals.

On Lake Erie, Port Colborne.—Of particular interest to the United States and especially to the Barge Canal is Port Colborne, across the lake from Buffalo. Port Colborne is the Lake Erie entrance to the Welland Canal with its capacity for 2,500-ton vessels. The New York Barge Canal when fully completed will also take vessels of 2,500 tons. Port Colborne is 369 miles from Montreal as compared with Buffalo's 497 miles to New York. This port will soon have another advantage. Only a few years after the opening of the New York Barge Canal, the Welland Canal, as planned, will be increased to permit the passage of 10,000-ton Lake vessels. Such standard Great Lake carriers can load at the Head of the Lakes and make a continuous trip to Prescott on the St. Lawrence, only 119 miles above Montreal. It will then be possible from elevators in Prescott to lighter alongside the ocean ship at Montreal at an expense very little greater than the lighterage service in New York harbor. The elevators of Prescott will then be within order distance of Montreal. When a ship in Montreal Harbor requires grain cargo for distress room, it can be telephoned for and still catch the steamer. In addition to this all-water haul from Fort William, Montreal is only 2,760 miles from Liverpool as compared with New York's 3,036 miles, or 276 miles nearer. If it were not for the one-sided load factor at Montreal, that port would have an incontestable advantage.

On the other hand Buffalo has eighteen great elevators as compared with only one large government elevator at Colborne. This enables Buffalo to store a reservoir of grain during open navigation on the Lakes. During the winter Buffalo has open to her by rail the entire "Atlantic Range" with many different railroad connections to various ports. Grain therefore may be stored in Buffalo and held for the higher winter prices and yet it can be moved on short notice to take advantage of favorable market or transportation conditions. Buffalo as a port suffers from the lack of a single port authority with complete coördination of all railroads and other facilities.

In spite of certain advantages and much energy on the part of Canadian ports, better port organization plus the Barge Canal should insure the United States ports Canadian grain to offset the sinking volume of American grain for export.

Gulf Port Competition.—The three Gulf ports, Galveston, New Orleans, and Mobile, are in close competition with each



(From report by Ford, Bacon and Davis, 1913)

FIG. 14.—Deformed map showing difference in export railroad freight rates in cents per 100 lbs. (cwt.) between New Orleans and Galveston, and between New Orleans and Mobile. (In strict usage " cwt." means an English hundred weight of 112 lbs.)

other. The manner in which railroad rates to each port can equalize the advantages which one might have over the other is illustrated graphically by a deformed map Fig. 14. This interesting document shows the difference in export railroad freight rates expressed in cents per 100 pounds between the ports mentioned.

New Orleans has a latent advantage of staggering magnitude. This is the Mississippi River as a traffic highway of the future which will be to New Orleans what the Rhine has been to Rotterdam, and the Elbe to Hamburg, only many times magnified. The Mississippi valley rail rate was based on the river rate of about 1900. If the river navigation is developed on the same scale as other river navigation systems, the river rate should be reduced at least 30% as compared with the rate under the old inefficient conditions of 1900. A reduction of 30 per cent. in the rail rate to New Orleans as compared to the other ports should be the logical result. Moreover, the revival of water transportation under modern conditions should bring to New Orleans an enormous export coal traffic to aid us in the exchange with South America. The movement on the river would have a favorable load factor with the development of importation of Cuban ores, raw sugar, hides from South America, sisel from Mexico, etc. The barges would develop a two-way haul, a load balance which would be of enormous economic advantage to the entire Mississippi valley.

Special Port Tariffs.—An example of how the railroad rates may be changed to favor a nation's seaports is illustrated in the case of the German Empire during recent years. The natural rivals of Bremen and Hamburg are Amsterdam, Rotterdam, and Antwerp. The natural course of southern and western German traffic is to Rotterdam, if bulky, and to Antwerp, which saves a week's time, if the freight is of high specific value. To overcome the natural disadvantage of the more remote German ports as compared with the ports nearer to certain parts of the Empire and also nearer to the open sea, the railroads have granted very marked rebates on export freight routed through the German ports. The rebates are of such a nature and the effect on the development of the ports in question so marked that it is worth while to quote here from Dr. Clapp, "The Port of Hamburg," p. 164–5, and from the report of Consul General Thackara.

"We are particularly interested in one class of exceptional tariffs, the import and export rates, for they affect the German seaports.

"Most of the export rates apply to all exports from Germany, whether by sea or land; but, in case the shipment is destined for a seaport, the export rate is usually allowed when the port is a German one. This condition is attached to L. C. L. shipments for export by sea. When sent over German ports, they are accorded the ton-kilometric rate for full carload shipments of general merchandise, 6.7 pfennings, varying with the distance. This is an important one for them, because a large part of German exports consists of specifically valuable, not bulky goods, often sent in less than carload lots.

"Similarly effective are the rates accorded German manufactures, particularly iron and steel, exported via German ports. Examples of these compared with the normal, inland rates, are as follows:"

Inland and Export Rates for Manufactures

(Rates per metric ton (2,204 lbs.) for shipment in ten-ton carload lots)

From	To	Kilometers	Miles	Articles	Rate			
					Export in Marks	In $	Normal in Marks	In $
Cologne	Hamburg	430	267.2	Copper goods, lead in blocks, pipes.	13.30	3.14	26.80	6.38
Cologne	Hamburg	430	267.2	Zinc in sheets.	13.30	3.17	20.40	4.86
Cologne	Hamburg	430	267.2	Cotton goods.	15.30	3.64	26.80	6.38
Cologne	Hamburg	430	267.2	Machinery, machine parts, iron wares.	10.60	2.52	20.40	4.86
Cologne	Hamburg	430	267.2	Iron plates, locomotives, etc.	5.60	1.33	16.10	3.83
Frankfort	Hamburg	532	330.6	Machines, iron wares.	12.90	3.07	25.20	6.00
Frankfort	Bremen	459	285.2	Machines, iron wares.	11.30	2.69	21.90	5.21

Import Rail Rates in the United States.—In the 1912 rate case *imports* figured for the first time. Imports from Europe to this country had always been light. The steamship companies came here to get freight to Europe, but made the trip west profitable by the passenger business, in particular steerage traffic. From Europe all freight rates to all American outports from Montreal to Norfolk were made equal. At the same time from 1905–1910 the volume of American imports to the growing manufacturing centers of the Middle West grew rapidly, particularly in hides, ferromanganese, burlaps, kainit, clay, palm oil, brewer's rice, seeds and the like.

The competition of Montreal and New Orleans grew. These two ports, one exporting grain and the other cotton, saw that in order to attract the shipping to move the exports they must make the ports attractive for ships to carry imports to these ports and thus have a full round trip load.

The standard rate had long been 75 cents from New York to Chicago, until the war came. The practice is to quote a rate in the per cent. of the Chicago to New York rate. Montreal took an all-rail import rate of 59 cents and a Lake-rail rate of 41 cents on imports to Chicago. Baltimore had a 67-cent rate and Philadelphia one of the 69 cents. Boston published the Baltimore rate of 67 cents. The I. C. C. in 1912 decided that under the Elkins act this was illegal and the result was that Boston was put back onto the New York 75-cent basis. Boston is heavily handicapped by the rate ruling and its advantages in ocean service are nullified by the roundabout "differential" rail routes to the interior. Testimony was given that in December, 1912, 68.7% of the cars moving west from Boston were "empties." "Under these conditions every ton of imports is something to put in a car that will otherwise go west empty."[1]

The extent of the rate differentials through various ports to western points reflects the extent of the effort of the ports which most greatly need the incoming freight to balance the load factor.

DRY GOODS AND WOOD PULP (Jan., 1918)

To	From New York		Philadelphia		Baltimore		Boston		Portland, Me.
	Dry goods	Wood pulp	D.G.	W.P.	D.G.	W.P.	D.G.	W.P.	D.G.
Chicago	90	21	84	19	82	18	90	21	90
Detroit	70	16.4	64	14.4	62	13.4	70	16.4	70
Cincinnati	78½	18.3	72½	16.3	70½	15.3	78½	18.3	78½
Indianapolis	83½	19.5	77½	17.5	75½	16.5	83½	19.5	85½
St. Louis	105½	24.6	99½	22.6	97½	21.6	105½	24.6	105½
Minneapolis	130	32	124	30	122	29	130	32	130
Sioux Falls	163½	40	157½	38	155½	37	163½	40	163½
Council Bluffs	160½	36	154½	34	152½	33	160½	36	160½
Lincoln, Neb.	165½	39	159½	37	157½	36	165½	39	165½
Kansas City	160½	33	154½	31	152½	30	160½	33	160½

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[1] CLAPP, "Port of Boston."

Freight Solicitation.—A port can overcome differentials to a large degree by port improvements which will make the handling of the shipment more rapid and otherwise cheaper. Unless this fact be brought to the attention of the western shippers there is little likelihood that they will change from their established routing, especially in the face of a combination of established practice and preferential freight rates to one particular port. An example of the working of an established practice is illustrated by the continued routing of war exports via New York because the indents of the goods and therefore the financing were made out F. O. B. New York.

There are three main sorts of solicitors of western traffic. (1) The steamship freight agent, (2) the commercial agent of a railroad, and (3) the western representative of the New York freight forwarders or freight brokers. The latter consolidate the less-than-carload shipments and attend to the details which are difficult for the inland shipper to handle.[1]

It is possible for the Directors of a port to have their own traffic department, and through agents or publicity of various sorts to educate the shipper to the advantage of the new route. It is possible even to solicit traffic for a particular route.

The example of Manchester is illuminating. Manchester, an inland city, spent $80,000,000 and built a 35-mile ship canal around Liverpool. How now to get the established habits of business to leave the old via-Liverpool route and pass through the port of Manchester? The Traffic Department of the Manchester Ship Canal Co. engaged the steamship companies to come to Manchester. Then it arranged with the railroads for lower rates on the basis of the much shorter haul to Manchester, as compared with Liverpool, from the centers of the great industries. Divisions or allowances to the belt line of the port were procured from the railways which made the belt line self-supporting. The harbor dues and charges were carefully calculated to leave a financial inducement for shippers to route via Manchester. The Traffic Association has a field force of thirteen solicitors travelling out of Manchester to the manufacturing centers. These solicitors carry rate cards of the Manchester steamship lines and demonstrate that the shipper will get the same ocean rate out of Manchester, a lower rail rate to Manchester, and that in addition this rail rate will put his goods alongside while in Liverpool the shipper will be put to the heavy expense of carting and handling.

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[1] Clapp, "Port of Boston."

The freight is actually booked by the agent of the carrier. The traveller for the Port Traffic Department simply acts as an aid in cases of obdurate prospects. The prosperity of Manchester is as much the result of good salesmanship as it is of the excellence of the port itself. A port with a superior service to sell should have no trouble to sell it by the established commercial methods of publicity and salesmanship. It is true of port traffic that "to him who hath shall be given and from him who hath not shall be taken away even that which he hath." This strong tendency of traffic to flow through the large port because of more frequent sailings can be changed by good salesmanship on the part of the smaller port.

CHAPTER V

THE HARBOR BELT RAILWAY AND COMPETITION AT THE TERMINALS

It has been seen that the peculiar railway history of the United States in most cases except New York has led to the development of "railway ports." By the railway port is meant a water terminal of a railroad company over which it exports the products of the interior served by its lines. When it is considered that even at the port of New York, embracing a metropolitan area of 7,000,000 people and 10% of the industrial production of the United States, 50% of ocean freight passes on into the interior, or at Boston 65%, or at Philadelphia 75% of import freight goes to the interior by rail, the interest of the railroads in the movement is obvious. On each transatlantic sailing from a port the earnings of the railways are from $30,000 to $40,000.[1] With the exception of New York, port development in the United States has been of one railroad, by one railroad, to serve one railroad. The waterfront, the railroad pier, and even the line of ships berthing at the pier have all come to be considered by the railroad as a part of its own private system. This viewpoint, it will be seen, has been inimical to both the public and the roads.

When the rate structure solidified about forty years ago the only competition between the railways left was the competition at the terminals. The effect of this competition at the terminals for maritime freight has been to disrupt American ports into as many disconnected sections as there are railroad terminals at the port. The result has been disastrous to American port development. Therefore all hope of improvement is inseparable from the question of competitive vs. union marine terminals.

The luxury of competitive passenger terminals is visible to all. The competition at the terminals for freight is no less keen although less conspicuous. It is presumptuous to ask the railroad to abandon any advantages which it has gained by years of work and to open its piers to all. Until there is an authority in the country which is higher than the railroads and above reproach of bias, there can be no more hope of the abandonment of this last form of railroad competition than there is of the abandonment of competition in national armaments until there is a world's court and world's police force to protect justly the individual nations. One of the most cogent reasons why American ports are lacking in coördination to-day is because the railroads will not and can not abandon the last element of competition left to them, the competition at the terminals.

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[1] Clapp, "Port of Boston." (This thorough work should be studied in connection with the railroad side of port development.)

Before considering the cure, the Harbor Belt Railroad and the United Port, let us study the bad effects of the present railroad competition at marine terminals. To repeat, this is the crux of the port development problem.

As a simple example of terminal competition at railroad ports, by way of introduction, may be taken Fort William and Port Arthur at the Head of the Lakes. These two ports are excellent examples of the needless duplication of the private unit system. There are twenty-four elevators and many other port installations with no coördination, operated by private interests with no regard for the economic advantage to the Dominion as a whole.

It is the old story of a port built by a railroad. In this case the Canadian Pacific Railway developed Fort William as a place to which grain might be brought for transshipment to lake steamers. The road took all the best territory for itself. Then came the second road, the Grand Trunk, and took what was left. When the third road, the Canadian Northern, came along there was nothing left at Fort William, and, therefore, it was forced to develop a terminal of its own at Port Arthur only a short distance away. This would not have been necessary under the proper belt-line development which would have made every wharf and every elevator part of every railway system.

The result is a difficult situation. An elevator company seeking to locate at the Head of the Lakes demands rail connection by two railway lines in order to have some assurance of not being held up by an accident to any one line. With each road jealous of its own terminal interests, it is difficult to find a location where such double service is possible. As a result there is a wide variation in the desirability of locations. The desirability could be diffused and thus open extensive building areas to the development of the port if there were coördination by means of a belt line under a permanent, publicly owned port in the place of the many-unit system of private interests. Nearly all of the Canadian and American Great Lake ports are railroad ports in the sense in which we have used the term before.

Railroad Competition and Terminal Charges.—Terminal competition between rail lines at a seaport involves the vast problems of wharfage, switching, and lighterage charges. The principle involved is this. The railroad will absorb wharfage, lighterage, and switching charges in the through-freight rate of tonnage carried over its own lines, but can not do so on freight transported to the interior over the rails of a rival company. Each rail terminus thus becomes a port in itself. Furthermore, any port property, like the elevator sites at Fort William, or the waterfront at Boston, can not compete against the free wharfage, free switching, in short, the free terminal of a railroad.

The switching and other charges absorbed in the through rate of a railroad are generally considered as of no interest to the public or none of its affair. On the contrary, the terminal charges of the railroads involve the entire development of the port and therefore are most emphatically the public's business.

It is perhaps easier to illustrate the principles involved by taking Boston as a case in point. At Boston, reaching the harbor from the South, West, and North, are the three railroads, the New Haven (N. H.), the Boston & Albany (B. & A.), and the Boston and Maine (B. & M.). The B. & M. and B. & A. are well coördinated by an outer belt line at East Somerville. The N. H. system is not so coördinated. To get at the workings of this sort of an arrangement at Boston, as an example, it will be just as well to quote several paragraphs, somewhat condensed, from the results of the investigations of Prof. Clapp while on the Boston Harbor Commission.[1]

> "It is important to remember what the flat Boston rate, the published schedule, includes, and what switching charges mean. For the flat rate to Boston the railroad delivers to its own public terminals. For the flat rate it unloads and delivers at its own freight houses less than carload lots (L. C. L.). In carload lots (C. L.) the rate includes delivery to teaming tracks or to industries having a siding. For export it delivers C. L. freight at its own pier.

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[1] See Clapp, "Port of Boston," p. 31 ff.

"But if one carrier brings freight destined for the piers of another carrier it charges the other carrier for switching. This charge may be invoiced to the shipper or it may be absorbed in the through rate. In this case the carrier would itself pay the switching charge to its

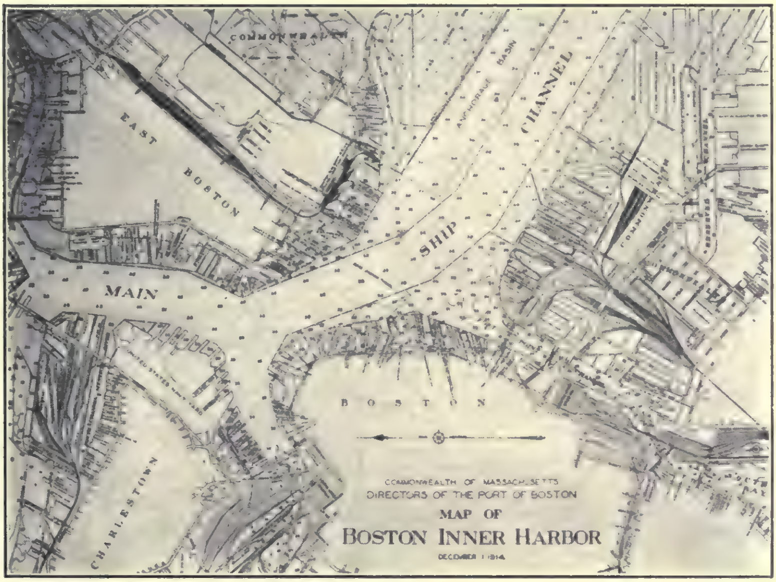

FIG. 15.—Map of Boston Harbor. (Grosvenor Jones.)

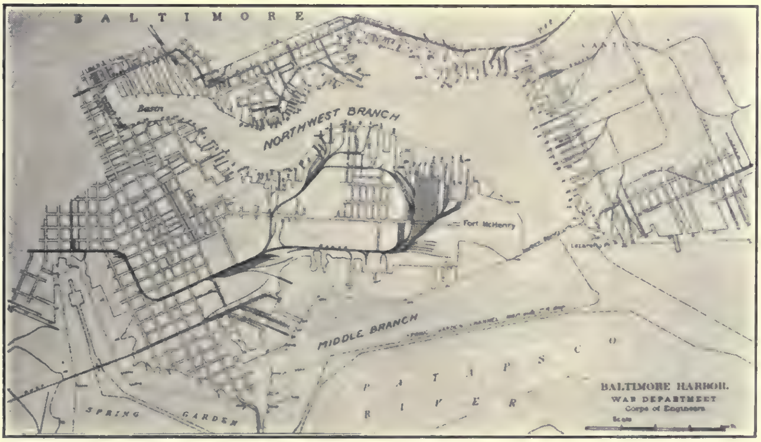

FIG. 16.—Map of Baltimore Harbor. (Grosvenor Jones.)

rival pier owner as an item of cost of operation in order to get the business for its own line. This is often determined by the fact that the shipper is at a "competitive" and not a "local" point. A local point is one having no competing rail connection.

"Concord is such a local point on the B. & M. The rate to Boston is, say, 10 cents per 100 pounds. This would deliver the freight to the railroad's Boston pier. If the freight in the car is for export by a steamer berthed at the B. & A. pier at East Boston, the B. & M. charges the regular rate of 10 cents per 100 pounds, but delivers the car to the B. & A. line at the junction belt line at East Somerville. The B. & A. charges the shipper 2½ cents per 100 pounds with a minimum of $5 per car to deliver the car to the ship at its piers. It therefore costs the Concord shipper 12½ cents per 100 poundsmore to ship via a steamer berthing at the piers of the B. & A., which does not pass through his town, than to ship via a steamer which berths at the piers of the B. & M., which does pass through Concord.

"The case is identical in principle, but just reversed in the case of a shipper in the town of Ludlow, a local point on the Boston and Albany. It costs him 2½ cents or 25% more to ship his freight via a steamer berthing at the piers of the Boston & Maine.

"As for the New Haven its patrons are better off in most cases because the N. H. reaches nearly all points reached by the B. & A. The few local points on the New Haven, however, have to pay an additional charge of three cents if their freight can not be shipped from the Charlestown piers of the New Haven. There are many other combinations. Altogether the Charlestown piers have been the most desirable because they have had several advantages in rates and connections.

"The question now is how this affects the steamship lines in their desire to call at a port and berth at other than the Charlestown piers. Given two competing steamship lines between Boston and Liverpool: one berths at the piers of the Boston and Albany at East Boston, and the other at the Charlestown piers of the Boston and Maine. A shipper gets a 10-cent rail rate to the Charlestown piers and a steamship rate to Liverpool of 12½ cents, making the freight to Liverpool 22½ cents.[1] Now, if the shipper has to pay a rail freight at 12½ cents instead of 10 cents to the East Boston piers, the through rate to Liverpool will be 25 cents instead of 22½ cents. The steamship line berthing at East Boston will, therefore, have to cut its own rate of 12½ cents to 10 cents to meet the through rate of 22½ cents, in order to compete with the other Liverpool ship at the Charlestown piers. The ship line with a cut of 20% in its freight rate will be discouraged from coming to the port, because other than railroad berthing facilities will not enable it to compete with other ocean carriers which have secured some of the few favorable positions.

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[1] Of course under pre-war conditions.

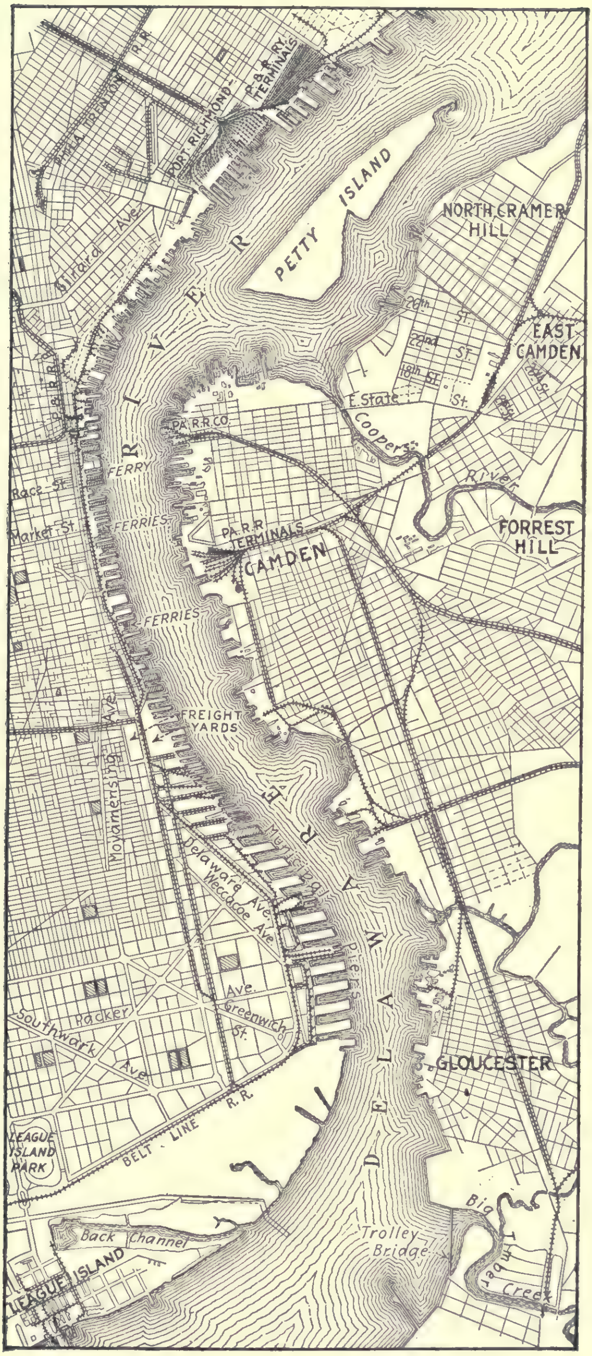
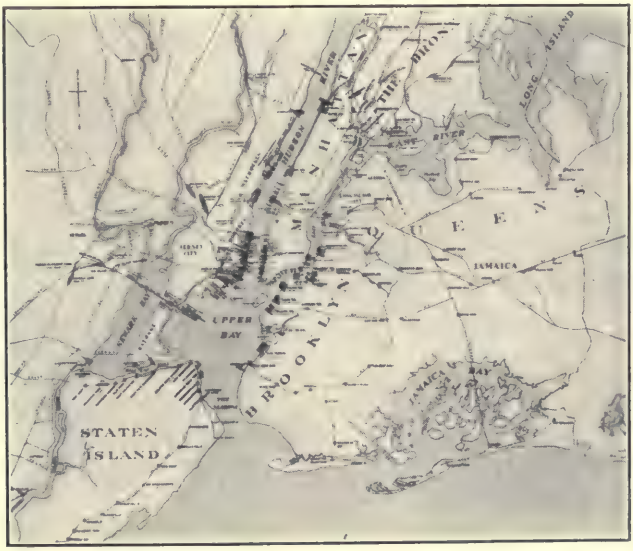


FIG. 17.—Map of port of Philadelphia.

"This inequality between the shipping lines will also work to the disadvantage of the shipper, because of its inflexibility. Take a case brought to the attention of the Port Directors. The International Mercantile Marine Company had operating to Liverpool the White Star Line from a Boston & Maine (Charlestown) pier and the Leland Line from a Boston & Albany (East Boston) pier. The Leland Line had practically weekly sailings; the White Star Line sailed fortnightly in summer and monthly in winter. During the winter several cars of paper arrived from Maine over the Boston & Maine, consigned to the International Mercantile Marine Company for export to Liverpool. It happened that the cars missed the White Star boat. There would not be another White Star sailing for a month. A Leland liner sailed the next week from East Boston. The I. M. M. Co. could not, as it could at New York or any other port having a full belt-line equipment, divert to any pier in the harbor a shipment paying the inland export rate. The steamship company had the choice of holding the freight a month, or taking, via East Boston, 50 cents per ton less than its contract ocean rate. It held the freight until the next White Star's sailing."[1]



(Courtesy of Merchants Assn., N. Y.

FIG. 18.—Railroad map of port of New York.

The Belt Line.—The solution of the problem of rail coördination at a seaport is the *belt line*. There are two sorts, the outer belt line and the inner belt line.

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[1] CLAPP, "Port of Boston," pp. 31–35, condensed somewhat.

The outer belt line is a rail system encircling the port city and tapping all the freight lines' tracks at some point before the tracks enter the congested parts of the port city. The outer belt line with its classification yards, its *gares de formations*, enables a car to be interchanged from the lines of one company to those of another.

The inner belt line connects the piers and wharves of the port in such a manner that a car loaded at any pier may travel to any other pier or to any railroad line. The important freight movement is not from one pier to another, but from pier to railroad trunk line. Therefore there must be ample connection between the inner belt line and the outer belt line to enable any car loaded at any pier to travel over the harbor belt-line system to any one of the railroad systems entering the port. Such a system of belt lines enables any freight car to be loaded at any pier at which a ship may berth and be switched to any railroad trunk line which will carry it to the consignee in the interior. The belt line should give complete mobility between any pier and any railroad system.

Contrasted with the railroad ports just considered, some examples of successful harbor railroads are instructive.

Belt Lines: Montreal.—Montreal is one of the most conspicuous examples of a publicly owned and operated harbor belt line. It has been most successful. The Harbour Commissioners of Montreal own and operate a belt line serving seven and one-half miles of waterfront with 49.11 miles of track. About four miles were added during the year 1916.[1] Mr. W. G. Ross, President of the Montreal Harbour Commissioners, at the Fifth Annual Convention of the American Association of Port Authorities, described the system as follows:

> "Previous to 1907, the railway tracks on the harbor, all of which were owned by the commissioners, were leased to and operated by the different railway companies. There were three units of this character extending the entire limits of the harbor. Under that system, so far as interchange of business was concerned, the shipper was subject to very considerable delay in that the line bringing the goods in for delivery to a connecting line was not particularly interested in expedition, and in addition, the charges were excessive, because each particular unit handling cars originating with another railroad or another unit, destined for delivery to still another, charged its own particular switch-

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[1] *Report of Harbour Commissioners of Montreal for 1916 and years previous.*

ing rate. As a result if a car came in on a railroad occupying the upper limits of the Harbor and had to transfer to one in the lower portion, the switching charges amounted to something like $12 per car with a delay of several days in some cases. Now that same service is performed expeditiously at the rate of $5 for through traffic and $2.50 to any point in the Central Harbor. The Commissioners have, therefore, demonstrated the economic advantages of publicly administered switching facilities to the shipping public."

Under the present system, the different companies at points designated in the Harbor hand over their cars properly marshalled to the Commissioners, who place them where desired, at the freight sheds, grain elevators, and other places for loading and unloading. With the redistribution of railway tracks, the cost of moving freight to and from the cars has been reduced by the Commissioners from 45 cents to 22½ cents per ton, practically eliminating the expensive use of the tracks, with their attendant congestion. The length of the Harbor shore line at present served by the Harbor Railway is seven miles, but the total mileage of track is 50 miles.

This railway not only affords facilities for transshipping freight and switching cars from one railway to another, and from railway to wharf and vice versâ, but also connects with the different industries located along the Harbor front, to which are shunted coal, raw materials, supplies of different kinds, and from which manufactured goods and finished articles are shipped out to all points of the country or to the steamships in the Harbor. Before the advent of the Harbor Railway these industries were obliged to dray every pound of freight in and out, a most expensive process; while now for $2.50 a car, their incoming freight is deposited at their doors and their outgoing cars are delivered to any avenue of transportation going out of the city. The rates charged by the Commissioners for this service are very moderate, and so good is the time made that there is an urgent demand by new industries building up along the waterfront for the prolongation of the Harbor terminals to new sites and to wharves now being specially constructed.

A new line of traffic was developed by this department two years ago in the transportation of coal and other commodities from the ship's side to industries having connnection with the harbor tracks and vice versâ. The movement of this traffic by the Commissioners saved the industries a good deal in cartage and handling, the commodities being handled at so much per ton.

There is a plan on foot to electrify all the Harbor Railway, to eliminate dirt and corroding gases, and to effect economies. Also tracks have been laid along the available right of way and it has become necessary to expand the trackage by building an elevated system. Special provision has been made for trucking stations to expedite local deliveries by trucks.

The number of cars handled over the belt line has increased rapidly. This is a commentary on the desirability of the system.

1907	70,856 cars
1912	112,911 cars
1916	234,439 cars

Accordingly the earnings increased likewise

The statement for receipts and expenditures for the year ending December 31, 1916, shows the following figures:

Receipts, Railway traffic Dep't.	$375,089.27
Disbursements, Railway traffic operation, maintenance, etc.	274,498.12
	100,591.15

The moral is plain. The belt line can perform the service cheaper as well as better than private lines and leave the Port Authority a handsome surplus.

Belt Lines: San Francisco.[1]—"San Francisco is served by the Atchison, Topeka & Santa Fe, the Northwestern Pacific, the Southern Pacific, and the Western Pacific railroads. All of these roads are connected by rail and by carfloat with the State Belt Railroad, which is an integral part of the harbor system and reaches all of the terminals along the waterfront.

"The belt line is one of the most important adjuncts of the port of San Francisco. It was established in 1891 and is owned, controlled, and operated by the State Board of Harbor Commissioners. The total length of line is 3.70 miles.

"Formerly the line was operated in two disconnected divisions. When it was desired to transfer a car from one division of the belt line to the other it was necessary to use the carfloat operated by the Southern Pacific Co. This method of transfer was not only slow and inefficient but also costly, since the charges for car-ferry service ranged from $11 to $15 per car.

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[1] G. M. JONES, "Ports of the United States," p. 297.

"The two divisions were recently connected—and it is now possible to obtain uninterrupted switching service along the entire developed waterfront. A continuation of the road from Powell Street, its former northerly terminus, to the Government transport docks at Fort Mason has only recently been completed. A part of the line runs through a tunnel 1,500 feet long and much also on trestles. The extension of the belt line to Fort Mason cost $300,000 and the United States Government has agreed to pay to the Belt Railroad, in addition to the regular switching charge, a fixed amount on every car going through the tunnel until the cost of the tunnel proper is paid for.

"A number of miles of sidings and spurs have been constructed to serve the various industries and warehouses along the waterfront."

The rolling equipment of the Belt Railroad consists of five locomotives. During the year ended June 30, 1914, 112,075 cars, 73,901 loaded and 38,174 empty, were handled by the belt railroad. The total revenues of the railroad for the same year were $193,993.[1]

Although the Belt Railroad is now one continuous line, the service is still divided into two divisions, the northern and the southern, the dividing line being Market Street. The following is a list of switching charges:

	Per car
1. Moving loaded cars from a place in one division to another place in the same division	$2.50
2. Moving loaded cars from a place in one division to a place in another division	5.00
No charge is made for moving empty cars, either to be loaded or after unloading, when incidental to operations embraced in items 1 and 2, respectively.	
3. Moving empty freight cars from place to place within same division for loading or on order of shipper or railroad, and not loaded but returned empty to place within same division	1.50
4. Moving empty freight cars from a place in one division to a place in the other division for loading on order of shipper or railroad and not loaded but returned empty:	
If it crosses Market Street once in the entire operation	1.50
If it crosses Market Street twice in the entire operation	4.50
5. Moving empty freight cars from one division to another division on order of shipper or railroad, but not for loading as a part of the operation	2.00
6. Moving empty passenger cars between any two points on the Belt Railroad	10.00

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[1] G. M. Jones, "Ports of the United States," p. 297.

7. For use of team track and storage tracks for each twenty-four hours or part thereof	2.50
Cars loaded or empty remaining on any Belt Railroad track over twenty-four hours after delivery is tendered by the Belt Railroad will be charged storage for each twenty four hours or part thereof	2.00
8. Moving loaded baggage or express cars (such cars will be returned empty as part of the same movement without charge, provided that all movements of such cars are at the risk of owners)	5.00

New Orleans Belt Railroad.—New Orleans is the most advanced port in America in respect of scientific policy. The belt line is owned and operated by the Public Belt Railroad Commission. It is a municipal body of seventeen members, part of whom are appointed by the mayor and part by the various commercial organizations. They serve without compensation except the Secretary-Treasurer, who devotes all of his time to the work. The Public Belt Line serves eleven railroads.

The switching charge on competitive freight was $2 and has recently been advanced to $5. Although obsolete in some respects, the schedule following, taken from Jones, p. 242, illustrates the working of the system.

Switching Charges.—The following is a list of switching charges made by the Public Belt Railroad, which serves all of the public wharves:

Switching charges on all carload freight (except explosives) between switches, tracks, industries, and warehouses on the Public Belt Railroad and between all connections, $2 per car, initial movement; return movement, gratis.

For replacing, reconsigning, or changing location of cars, caused by error of consignee or any other cause not chargeable to the New Orleans Public Belt Railroad, an additional switching rate of $2 per car will be charged.

On carload competitive traffic received or forwarded via the New Orleans Public Belt Railroad for or from industries, switches, and warehouses located on the tracks of the New Orleans Public Belt Railroad, the switching charges of the New Orleans Public Belt Railroad are absorbed by connecting lines.

Cars that are received from connecting lines for industries or that are received from industries for connecting lines will, if refused, be returned at the expense of the road or industry from which they are received.

All cars are subject to demurrage charges under the demurrage tariff of the New Orleans Public Belt Railroad.

A charge of $3 per car as rental will be made for the use of cars furnished by the New Orleans Public Belt Railroad for loading to points within the switching limits of New Orleans, except where private cars are used.

Cars will be inspected to ascertain their availability for use under the rules, cleaned, and prepared for loading upon request of shippers. An expense charged of $1 will be paid by the receiving line for each car furnished.

Philadelphia is well on the road to a complete harbor railway which will fulfill all the rules of the most approved practice. Philadelphia was originally a railroad port for the Pennsylvania System. Then the Baltimore and Ohio gained entrance and finally the Philadelphia and Reading. According to a recent agreement with the city, a complete harbor belt line through South Philadelphia, Greenwich Point, open to all railroads present and future on a pro rata basis, is in course of construction. A measure of public control is assured by the ownership of 51% of the stock by the commercial interests of the city. It is impossible for the present roads to gain control or to exclude any new companies from the waterfront. The prorating is done by making a book charge to the railroad company receiving or delivering a car to the belt line of $3 to $4 a car. No switching charge is made to the shippers. When it is completed there will be rail connection between every pier and every railroad line entering the port of Philadelphia.

Seattle is a progressive port, but it has no belt line. Its port authorities have a franchise to build one, but the franchise has several missing links. The several railroad companies reaching the port have built their own rail connections to various parts of the harbor, and have fought the harbor belt line tooth and nail. The municipal wharves have spur tracks connecting them with one or another of the lines and with detached parts of the belt line. However, complete flexibility can be achieved only when the port authorities connect all piers and all railroads one with another by a completed harbor railroad system. A belt line with missing links is a delusion.

In European ports we find much to learn. When progressive at all, they have accumulated experience during many years. The harbor railway is considered by European ports to be a *sine qua non.*

Rotterdam.[1]—The first railroad from Rotterdam was the one to the Hague and Amsterdam opened in 1847. This road was built and operated by the Hollandsche Iyzeren Spoorweg Maatschappij. The line to Utrecht and Emmerich, up the Rhine valley, was built by the Rhine Railway Company and finally the roads to the south were built by the Netherlands Government and operated by "The Company for the Operation of the State Railways," called for short the "S. S." or "Staat's Spoorweg." When the port of Rotterdam began to build rail connection with the waterfront there were these three companies, the Hollandsche, the Rhine, and the Staat's, entering the port. In 1890 the Staat's absorbed the Rhine system and to-day only the two remaining companies, the "S. S." and the "Hollandsche" are to be considered in the belt-line development. The intention of the government was always to play off the one against the other and preserve competitive conditions. This was a failure in the Netherlands just as it has been in other countries. The railroad business is not a business which will work under conditions of competition. It is a public utility and not a competitive private business. America is the last great country to realize that fact, because the service of civilizing the great west, which was accomplished by the private American railroad companies, is too fresh in our minds to admit of our full appreciation of changed conditions.

The Port of Rotterdam was managed for the city by the Rotterdamsche Handelsvereeniging. They built the first tracks at the harbor and turned them over to the State Railroad for operation. The arrangement was not fair to the city and the following agreement was entered into in 1889.

All railways to be constructed on municipal territory on the left bank of the Meuse, the foundations (dykes, bridges, ballast, etc.) are to be paid for and kept in repair by the municipality, the superstructure (rails, sleepers, turntables, etc.) by the State Railroad. The State Railroad pays annually to the Municipality 4% of the value of the construction prior to the agreement. The State Railroad agrees to include in its operations all the tracks in the harbor at the same freight rates as charged for its own terminal, the Feyenoord Station. If the system is extended beyond the Barendrecht Basin a charge of six cents Holland money ($2\frac{2}{5}$ cents U. S.) per ton is allowed. The State Railroad pays the municipality one cent a ton on all freight hauled over the city's belt-line tracks and contributes six cents for every meter of track towards maintenance. Provision was made for the arbitration of disputes, but none have arisen requiring arbitration. The agreement was for twenty-five years, after which time the system might be taken over entirely by the municipality for a sum to be determined by assessment. The Municipal State Railroad had 41 kilometers (25½ miles) of tracks in 1907 and was growing rapidly.

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[1] "The Port of Rotterdam," H. A. Van Ysselsteyn, p. 97.

When it became necessary to build harbor basins on the south bank of the river Meuse, the right of constructing the tracks and operating them was given to the other road, the Hollandsche, under almost the same contract as that of the "S. S." This contract expires in 1925. Each railroad company has joint use or "running rights" over the harbor tracks of the other.

According to the agreement with the Municipality of Rotterdam the switching charges are all absorbed in the through-freight rate, yet the two lines and the Municipality have the benefit of coördination of rail carriers and of inner harbor movement by rail. The Rotterdam system of municipal ownership and joint operation seems highly adaptable to American conditions.

Hamburg.—The Harbor Railroad (Hafenbahn) at Hamburg[1] has 213.62 kilometers of tracks, or about 185 miles. This is quite an intensive development in consideration of the small area of its port. The Harbor Railroad is owned by the city and operated by the *Wasserbaudirection,* the permanent port authority. The railroads charge their regular freight rate to the termini of their lines. From the terminus yard the Harbor Railway takes the cars and switches them to the desired quay. This switching charge is naturally higher than the ton-mileage charged for the line haul. On the other hand the line haul may be lowered as the terminal charges need not be absorbed. The switching charges are as follows:

1. General package freight, L.C.L., minimum 5 tons per car, 20 pfg. per 100 kg.—2c. 100 lb.
2. Classified consignments, minimum 5,000 kg. (55 metric tons) maximum 5M. 10 pfg. per 100 kg.—1c. 100 lb.
3. All other freight in C.L. (5 ton min.) 15 pfg. per 100 kg.—1½c. 100 lb.
4. If it be possible to transfer directly from ship to freight car, 3 pfg. per 100 kg.—3 mills 100 lb.

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[1] Flügel, p. 204.

To discourage the use of the crowded quay sheds as far as possible there are tariff differences favoring shipments which like No. 4 do not use the sheds but go directly from ship to freight cars and leave the quay at once. This preferential tariff for non-shed freight is considerably lower.

	Package freight per 100 kg.	
	With shed use	Without
Quay loading and transferring (cranes)	3 pfg.	2½ pfg.
Official weighing and certificate	6 pfg.	4 pfg.
Harbor Railway	20 pfg.	3 pfg.
	29 pfg.	9½ pfg.
In American money this would be about	3 c.	1.1 c. ($1 = 4.20 marks)

In addition there is a fee of one-tenth of 1% for statistical declaration of both in and out-bound freight, reckoned *ad valorem*.

Bremen.—Bremen has a similar harbor belt railroad, but the switching charges are somewhat different from Hamburg's. The regular L. C. L. rates are 8 pfg. per 100 kg. ($.008 per 100 lb.) for freight using the quay sheds and 4 pfg. ($.004 per 100 lb.) for freight not using the sheds. There is a larger percentage of railroad freight at Bremen because there is little river navigation inland.

At Emden there are no switching charges at all as all of the harbor is reached by the Prussian-Hessian Railway alone and all the switching charges are absorbed in the through rate. There is absolute coördination between every quay and every line leaving the port for the interior, however, although Emden is a one-railway port.

London.[1]—At the port of London the same sort of inherited inconveniences exist as at many American ports. The older docks were built before the railway became a factor and most of the wharves of these docks are without any immediate rail connection. The condition has been maintained by the lighterage guilds which have shown great opposition to any improvements which would reduce lighterage by sending rail freight by rail. "Victoria and Albert" and "Tilbury" Docks are the only ones with rail connection in the Continental sense.

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[1] WIEDENFELD, p. 100.

Liverpool.—Liverpool also has no rail connections of importance. There is a railway passenger station on the waterfront. This was necessary because of the competition of Southampton which offered this convenience to transatlantic travellers. There is also an elevated railroad to connect with bunker coal pockets. The attempts at a harbor belt railway have been failures because the upland space left for such a system between the docks and the city is so narrow that only single tracks could be laid if there were any space for tracks at all. Some of the warehouses tried to use single-track rail connection, but the attempt was unsuccessful. It is absolutely essential to have two or more tracks in order to switch past cars which are loading or unloading at the freight platforms. Also at Liverpool much of the freight is for local consignees and not for the interior. Therefore at Liverpool all the freight is still carted from wharves to goods stations and warehouses.

Antwerp is thoroughly coördinated, with belt-line connection between ship's side and the interior. An extensive system of 97 miles of tracks links the quays with all the railway lines serving the port.[1]

Manchester.—To close the list of successful Harbor Belt Railways, which might be continued indefinitely, the following quotation will sum up the essential features of this vital institution[2] at Manchester.

> "The Manchester dock railways are eight miles in extent and completely intersect the dock estate. The total length of railways (tracks?) already completed at the docks and at many points alongside the ship canal is upwards of 137 miles. The following railways connect with the docks: London & North Western, Lancashire & Yorkshire, Great Northern, Midland, Great Central and Cheshire. The Canal Company's tracks along the canal between Manchester and Eastham are connected with the railways of other companies at different points. *Traffic can be conveyed in railway cars between the various loading and discharging berths at the docks and at other places on the ship canal, and over the different lines named to every railway station in Great Britain.* The Company supplies lists of through rates—inclusive of railway carriage and ship canal toll—for the conveyance of traffic between inland towns

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[1] *Report of the Connecticut Harbor Commission*, 1912, p. 48.

[2] *Report of the Barge Canal Terminal Commission*, Albany, p. 223.

and Manchester." The company is The Manchester Ship Canal Co., which is the owning and operating authority called "The Harbor and Port of Manchester."

Separation of Terminal Charges.—In closing the discussion of the belt line it must be pointed out that there must be not only full coördination but also equal charges. These two factors at New York, that all parts of the port are equally accessible, and at the same rate, are responsible for the growth of the port. The costs have been high and pier rentals have been high, but the service has far outweighed the free wharfage of other ports of the North Atlantic, which have been railroad terminals in the narrow sense of terminals for one railroad. The railroad has considered that the pier and then the ship berthing at the pier are parts of the private system of the railroad company. There have been no terminal charges against the freight in this case and the ships are given free wharfage at a railroad pier. Yet this free wharfage does not begin to offset the fact that the ship line has access only to the narrow hinterland served by one railroad system. The principle that a port must be one zone with equal charges to any part of it has been upheld by the Interstate Commerce Commission.

To unify a port and give it complete flexibility it has been said that the terminal charges should be separated from and not included in the line haul. It has been argued against this separation of terminal charges from the line haul that it is un-American; that European hotels may charge guests for candles and soap but that this is not the American way of doing things. The comparison limps. The terminal expenses are far greater than the line haul. In the example in Chapter I between Philadelphia and New York these expenses were fourteen times the rail freight rate. Is a first class American hotel which fails to include the cigars and champagne in the room rent un-American? With terminals operated as a unit there must be a separation of charges, even if these charges are eventually prorated and absorbed.

The first law of a port now reads: *There must be physical connection between every pier and every railway and every warehouse with a uniform system of charges.*

CHAPTER VI

LIGHTERAGE

The lighter is a shallow-draft vessel used for inner-harbor communication. In many harbors of the world where there are no adequate wharves the lighter is the only means of communication between ship and shore. Where the harbor has an insufficient depth of water, the lighter is used to "lighten" the ship by removing a part or all of the cargo. When the ship is "light" it can pass over the bar and enter the harbor.

The lighter is a necessary tool in any harbor no matter how well the harbor may be equipped. The harbor lighter and the belt line for freight cars are not antagonistic. The lighter, because of its greater flexibility, because of the greater economy of transportation on water, and because of the larger amounts of cargo which it can move at one time, is more economical than any land carrier, whether it be dray, motor truck, or belt-line car, provided the costs of loading, unloading and handling the freight be the same in all three cases. The cost of handling is the deciding consideration. The belt line has the advantage in almost all well regulated and properly planned ports in the movement of all railroad freight because the car can be switched over a belt line to the ship instead of having its freight unloaded between the point of origin and the ship's side.

For local delivery instead of cartage, between warehouse or industrial plants situated on lighterage waters within 50 miles of the ship, the lighter is undoubtedly the most economical and convenient medium. For loading ships in stream or from the water side it is the only medium.

To repeat, the question is not whether we shall adopt either belt line or lighter, but whether we shall make the fullest use and best possible adaption of both vehicles. There has been endless confusion and much complete misunderstanding of the relative functions of lighter and belt line. There should be no confusion of mind on the subject. The harbor belt line affords facilities for switching freight carriers between any railroad system and any steamship pier and any warehouse or industrial plant having a siding. Likewise the lighter affords facilities for moving freight in bulk or package from any ship to any other water carrier and to any warehouse or industrial plant having water-side connection. Both institutions are necessary to the efficiency of a modern port. The lighter is less economical than the belt line, in handling railroad freight, but more economical than the dray for other freight.

Lighterage at New York.—The lighterage situation at the port of New York demands detailed attention for several reasons, because of the importance of the port, because of the agitation, publicity, lighterage cases before the I. C. C., because of the congestion at the port of New York, etc., and because New York, not having a harbor belt line, must depend upon the lighters to do not only their own work, but also the work which should be done by a belt line. It must be kept in mind, out of justice to New York, that not only is the problem of harbor coördination most urgent at New York, but also its solution is most difficult of attainment there, because of the peculiar geographical, legal, and historical conditions at this, our first maritime gateway.

There are three categories of lighterers at the Port of New York, *private, charter, and public.* The private lighterers are the departments of a railroad or terminal company to take care of that particular company's own lighterage work.

The charter lighterer is a private lighterage firm which does not operate its lighters, but leases or charters them to such as need the equipment. Often when terminal or railroad operators have insufficient lighter material they charter such equipment. This is particularly true of floating derricks for lifting heavy pieces of freight.

The public lighters are common carriers, in distinction from the private carriers. They sell their services to the interested public at prices determined by demand and supply. As Mr. Bush said in testimony, "They take whatever money you happen to have in your pocket." This is a picturesque way of stating that they charge what the traffic will bear. The economic laws which determine prices under conditions of free competition operate here as elsewhere. Supply and demand fix prices, but only between two limits. The upper limit is what the traffic will bear, or, if you wish, the full amount of the contribution of the service to the value of the product. The lower limit is determined by the cost of the service. The price can not permanently sink below the cost of the service or the lightermen will be forced out of business. In times, as at present, when demand exceeds supply the lightermen take full toll. In slack years the price charged will sink to near the cost of production of the service. The "cost and service" principle therefore prevails.

There are no published tariffs for lighterage. Formerly, before the war, the rate to any point within the lighterage limits of the port was about five cents per 100 pounds. During 1917 it was between 7½ and 9 cents. There is no agreement between the lighterage firms, but each is able to gauge the market to within about one-half cent. In practice a lighterage firm establishes a reputation for careful handling, prompt delivery, and general reliability and thus seeks to gain and retain its own regular customers. Many specialize in some particular type of service such as the transportation of stone and gravel, coal, high explosives, etc.

The wages of labor account for 75% of the cost of the service. Twenty years ago big husky Irishmen were available at 20 cents an hour. At the outbreak of the war little Italians were receiving 35 cents and by the close of 1917 the most motley of crews were getting 55 cents an hour.

The Usual Equipment at New York.—The lighter is a wooden scow with high freeboard, square ends, and a somewhat greater length overall than on the waterline. There are three principal types of lighters of the scow type; open deck, covered deck, and open hatch. The last type is commonly called a barge or a scow.

The lighter has undergone a rapid change in size within the last 25 years. A generation ago the New York harbor lighter was a small sloop, pointed at the bow, carrying a mast and mainsail. It had a loading capacity of not over 90 tons. As in the case of ships and canal barges it has been found that the larger the carrying capacity, the greater the economy of operation. To-day a lighter of less than 300 tons' capacity is considered absolutely uneconomical and those of the more recent construction carry 600 to 700 tons. The percentage of profits on the transfer with a 600-ton lighter is more than twice the percentage of profits from a delivery with a 300-ton lighter. A modern lighter is normally worth about $12,000. At present (1918) it sometimes costs several times that amount.

A more recent development is the steam lighter. This is a large tug with the machinery well aft and an expansive foward deck to accommodate freight. A steam lighter has greater speed, is more mobile, has power for handling heavy pieces by winches and boom or derrick, and can also tow a scow lighter. Steam lighters have a capacity of from 300 to 500 tons. They

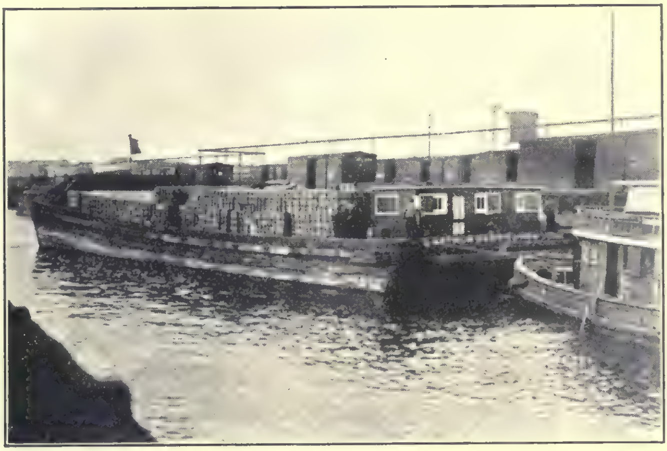
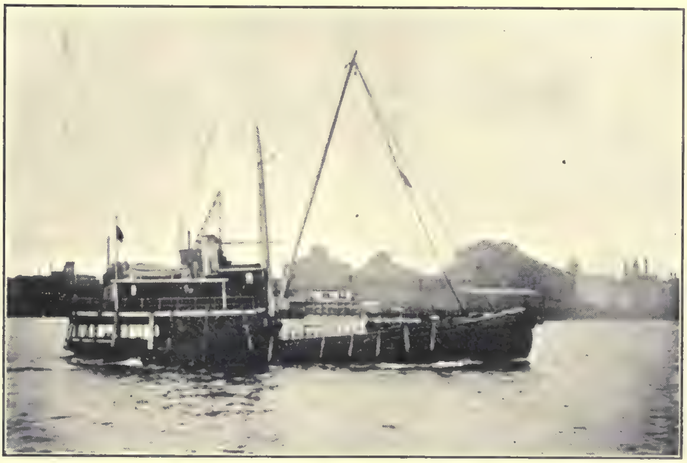


FIG. 19.—A modern 600-ton lighter continues the freight haul from the end of the railroad tracks.



(Courtesy of the Johnson Lighterage Co.)

FIG. 20.—A steam lighter with a capacity of 300-400 tons.

are worth (1917) about $60,000, but are almost impossible to get. Such a boat burns 1½ tons of coal per day and has a crew of five men. It is used for high class fast freight.

There are about a hundred lighterage firms at New York.

Wharfage on Lighters.—The lightermen's great grievance at the port of New York is the wharfage charge on lighters. Section 859 of the Greater New York Charter reads as follows:

> "It shall be lawful to charge and receive, within the city of New York, wharfage and dockage at the following rates, namely: From every vessel that uses or makes fast to any pier, wharf or bulkhead within said city or makes fast to any vessel lying at such wharf, for every day, or part of a day . . . . as follows:"

These wharfage rates according to the law are chargeable upon the tonnage of the vessel, but custom has pretty well established a flat rate of $1.00 per lighter, except at the city piers where the rate is one cent per linear foot on the length of the lighter. Now when a lighter is asked to deliver or collect freight by a ship at a wharf, it has to pay for going where it is asked to go and for performing an indispensable service to the ship. It has to pay the dollar even if it lies outside of the wharf, several vessels away from it, and also if it touches there only for a short time. A lighter may have to pay several dollars a day, one for each wharf at which it loads or unloads a package.

The wharfage on lighterage goes to the lessees of the pier who are often almost, if not quite, able to pay the rent of the pier from the wharfage charged against harbor lighters. A case in point is often agitated, that of the city pier leased by the Faber Line, at the foot of 31st Street, South Brooklyn. The line pays the city $36,850.50 per year, or less than 2% of the investment of the city. At one count 137 lighters had touched at that pier before 11 A.M. and each paid $1.00. The line practically has the pier for nothing, the lighters paying for it.

To charge lighters wharfage is to lay a tax on a service which should be encouraged. It may be wasteful in ordinary cases to lighter railroad freight. This is not always the case. However, at New York it is estimated that about half of all the maritime freight moves by rail. The encouragement of the movement of the other half by lighter to relieve the carting congestion in the streets of the metropolis has become a necessity. The degree to which the carting may be elminated by lighters deserves much study. It will be discussed under various headings in these pages. Just here in connection with this wharfage charge on lighters be it mentioned that the charge is a tax which may not seriously affect "belt-line lighters" carrying railroad freight, but will be very detrimental to the development of the small fast "dray-lighter" which has been found most useful in various ports abroad.

Lighters and ships have grown many times in size, but the pier slips have not widened. The result is much congestion. Lighters sometimes lose several days trying to get where they are wanted. The resulting waste of lighter service is the same as that of the freight cars tied up by congestion and not working. In recent cases the lighterman has collected from the owners or lessees of the piers for delays caused by slip congestion. In one case the damages collected were $75.00 per day of delay. The lighter missed a delivery to a steamer and had to hold the freight for five days.

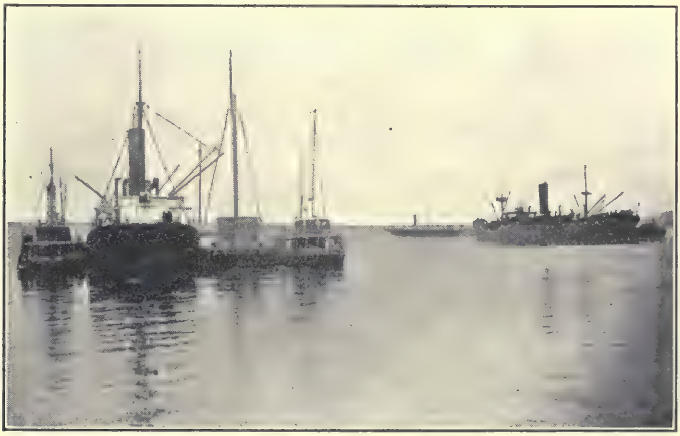


Fig. 21.—Instream loading without mooring posts.

The fact that the lighterage system is already developed at the Port of New York should be an additional incentive to the establishment of ship berths at dolphins or mooring posts for mid-stream loading. Mid-stream loading is practised now because of the lack of wharfage during the war and for loading of high explosives and ammunition. A ship at anchor, swinging at her moorings with every change of wind and tide, is at a disadvantage. Also simple anchoring requires too much room. At the port of New York there is plenty of room, it would seem, but the present congestion has made itself felt even on the waters of the harbor as well as at the wharves. There is plenty of area in the Upper Bay where the driving of rows of dolphins and dredging to accommodate the largest ships would be simple.

When the Barge Canal is in operation the volume of water-borne freight entering the port will be greatly increased. The conditions will be repeated here which have given the characteristic lighterage service to both Rotterdam and Hamburg. It will then be necessary to establish mid-stream loading facilities for both lighters and canal barges.

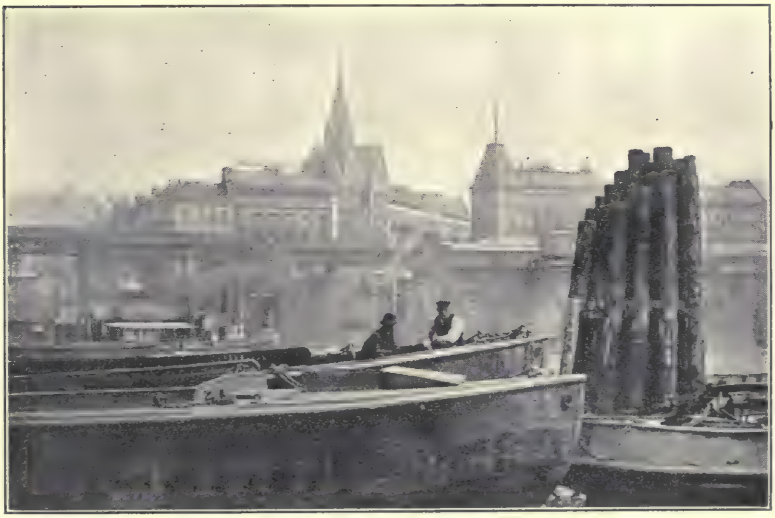


Fig. 22.—A mooring post or Duke d'Albe and steel lighters at Hamburg.

LIGHTERAGE AT OTHER PORTS

Waterside Delivery by Lighter at Hamburg.—The lighter movement of freight at the port of Hamburg has reached large proportions. There is a fundamental difference in the service rendered as compared with that of New York.

At Hamburg all the warehouses of the Free Port and most of the private warehouses and loft industries of the town have waterside delivery, that is, a canal on one side and a street on the other. For this reason the lighters do not take the place of the rail

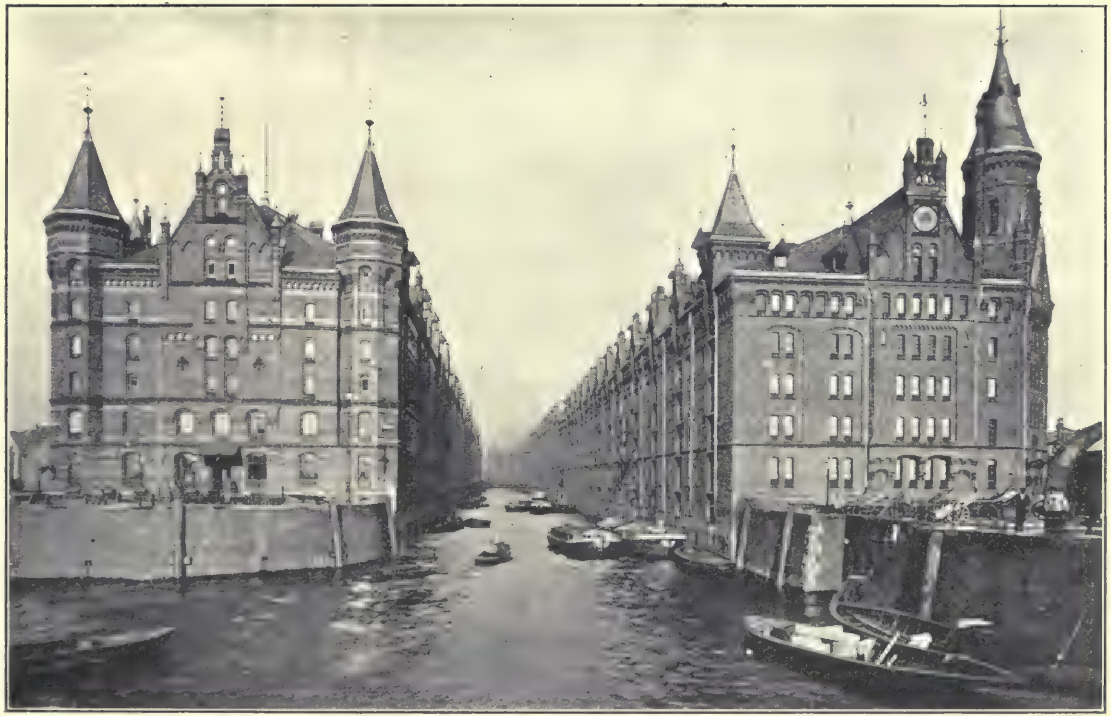


Fig. 23.—Warehouse group of the Free Port with canal constructed to furnish lighters and barge connection to one side of the rows of warehouses.

connections as at the Port of New York, but take the place of drays. Instead of a lighter moving the contents of a freight train to the ship it moves only dray loads for local shippers. The belt railway takes care of all the through railroad freight and switches loaded cars unopened to the quay where the ship is loading. When the freight comes by river barge the barge is floated along side the ship in stream or at a quay on its water side, and the cargo again reaches ship's side from the interior without rehandling.

In broken lots by rail L. C. L. freight is unloaded at the belt-line transfer station and consolidated for that particular ship and then moved to ship's side, sometimes in a freight car, or, more often, dropped over the water side of the transfer station into a lighter, and moved to ship's side by water just as at New York. Thus the lighter moves only L. C. L., railroad freight.

When a river barge has less than 50 tons for a steamer the barge is not allowed to lie alongside the steamer and unnecessarily interfere with navigation, but it must make delivery to the ship by lighter from the barge terminal. Again the lighter is used, but only for less than barge-load lots.

Ships lying at mooring posts do not pay wharfage. Therefore, as mentioned above, when a ship takes on a cargo composed largely of bulk freight or freight arriving in river barges and only in small part of package freight, it is more economical to take the package freight to the ship in lighters than to have the ship pay wharfage.

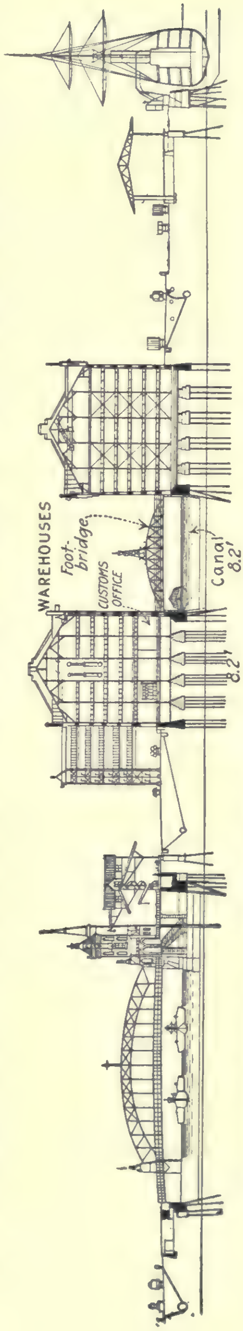
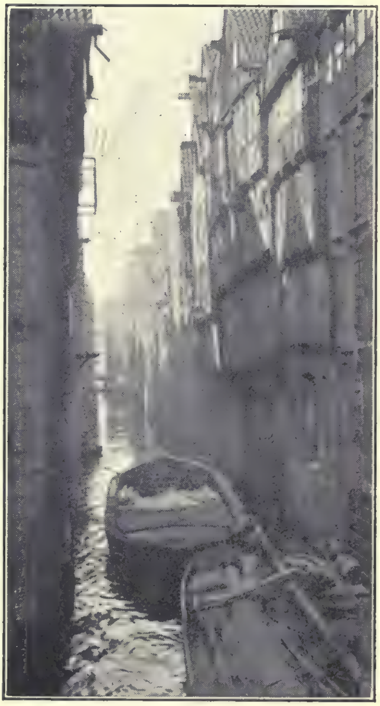


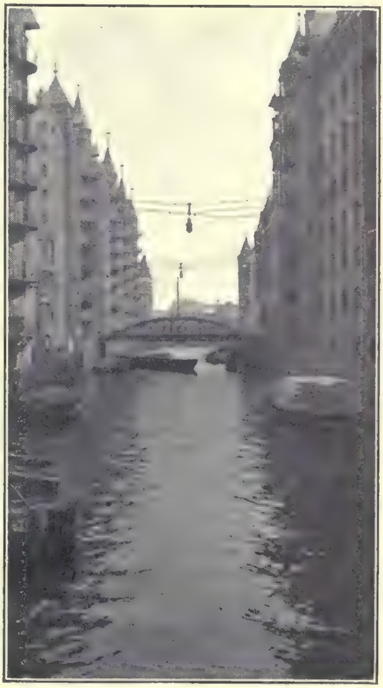
Fig. 24.—Cross section of warehouse district showing waterside delivery by canal to one side of the warehouses.

It will be seen that the lighters at the two ports have very different services to perform. At New York they move large consignments and the large lighter is in vogue because ton for ton the larger the movement the more economical it is. This rule holds only when most of the lighter service is for trainload lots. The lighter at New York is doing, rightly or wrongly, a water belt-line service.



(Photo by author)

FIG. 25*a*.



(Photo by author)

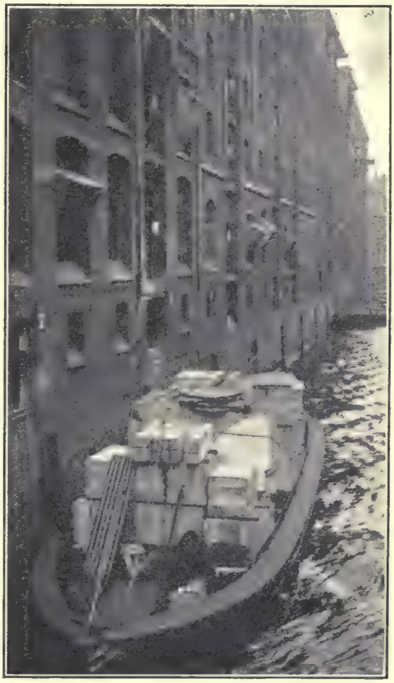
FIG. 25*b*.

FIG. 25*a*.—Hamburg. Ancient canal dating from end of 13th century with private warehouses built for lighter dray service. (See also chapter on Free Port.)

FIG. 25*b*.—Hamburg. Free Port Warehouse District, lighter canal is with arc lights for illumination at night. A lighter is delivering a consignment of coffee. Arc lights are to aid in policing free port warehouses as well as for night deliveries.

At Hamburg, where lighters move dray-load lots, a cartage service on the water, the small lighters are more economical. A small lighter full every trip will cost less per ton to operate than a large lighter only partially filled. For conditions at Hamburg small lighters are most efficient. They are of steel construction with pointed bows, a two-foot deck and combing around an unobstructed hold. The usual capacity is 50 to 75 tons. There are 500 covered and 2,500 open lighters[1] at the port with a capacity of from 30 to 300 tons. Open lighters are covered by tarpaulins in bad weather.

Formerly these small lighters were poled or staked from place to place. They were punted and floated from the harbor to the warehouse on the canals and back again, taking advantage of the rising and falling tide for the major part of their locomotion, going in with the flood and out with the ebb. Lately the usual means of locomotion has been a sturdy one-man motorboat burning petroleum or heavy oils. There are also some small, two-man steam tugs. The small, fast tugs and handy sharp-bowed lighters are most efficient drays.



(Photo by author)

Fig. 26.—Lighterage. A consignment of Adriance Pratt Reapers being "drayed" by lighter to the water side of the agent's Hamburg warehouses in the Free Port.

The rates are arrived at according to agreement influenced by supply and demand. The lightermen have a "Curb" outside the Bourse. When a transaction has been made on the exchange which requires the movement of merchandise it is only necessary to step outside to the Lightermen's Curb and bargain for the delivery. As at New York, old established lighterage firms have their regular customers. The rates are fixed by long usage at about 30 pfennigs per 100 kilos or 7½ cents for 220 pounds. This would be 3.4 cents per 100 pounds. It is evident that this is a very low rate in view of the fact that this is largely a L. C. L. dray service.

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[1] Clapp, also *Hamburger Hafer Statistick*, 1912.

The extent to which the lighter aids in the movement of goods at Hamburg is shown by an analysis of the removal of goods from the ships using the quays and not including the ships in mid-stream.

By Barges	17%
By Rail	18%
By Dray	20%
By Lighter	45%

It must be remembered in this connection that much of the commerce at the port is for re-export by coastwise vessels. The movement may be directly from ocean to coastwise vessel or it may be to the warehouse first.

The deep waterfront at Hamburg and elsewhere is not given over to local delivery. All freight shipped to the city—and a million people require a great many things—which comes by rail goes to terminal freight houses, to terminal municipal markets and to municipal stockyards, and is loaded or unloaded at properly equipped and planned sidings. Much of the garden produce comes by canal boat from the surrounding countryside direct to a quay along one side of the main municipal market area. Bananas and other over-sea fruit go to a special fruit quay which is equipped with banana unloaders and conveyors

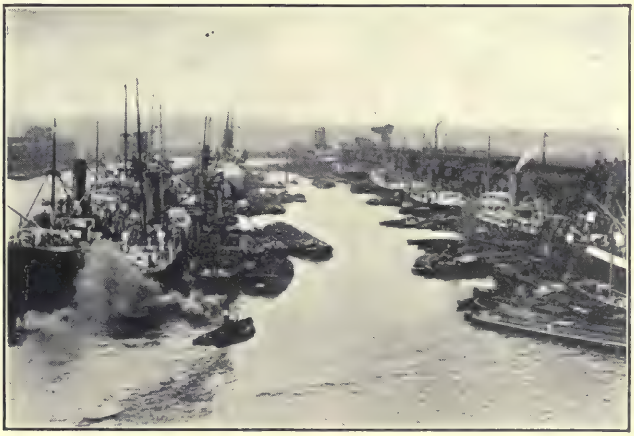

Fig. 26a.—Modern basin showing equipped quays with a center line of mooring posts, river barges and lighters serving vessels from waterside.

and other special transfer and handling machinery. This quay is in the free port, but not far distant from municipal markets. By such means the deep waterfront is reserved for overseas and coastwise commerce.

London.—Lighterage at London has not come up to its best possibilities. At London Lightering has been practised for centuries. This has been necessary because the docks have been built at widely separated points before there was a harbor belt line, and in the case of the older docks even to-day the only connection between them is by water. The distances are far too great for the dray or even the modern auto truck. This is a case where the lighter is the proper means of inner harbor traffic. The practice has been to move the lighters about the harbor on the ebb and flow of the tide. This means that there is a general lighter movement every twelve hours. The lightermen drift helplessly with the current except for an occasional use of the boat hook and a flow of picturesque language with which the lightermen express their mutual admiration. The difficulty of the movement is increased by the fact that the docks are only opened at high tide and the lighters must get in and out during this brief period. The ancient and strongly organized lightermen's guild has systematically opposed any introduction of motor tugs or other mechanical propulsion of lighters. The craft in use is very similar to that used in Hamburg. With the introduction of motor tugs and double gate locks instead of flood gates the lighters of London could be made one of the great assets of the port. As it is, the lighter is in great disrepute at the Port of London and gives a bad odor to anything which calls itself a lighterage system.

Application to United States Ports.—The question which we must raise after all this discussion is: "How are we able to adapt any of these advantages to our New York and other American conditions and cut the present excessive draying costs of 10 to 12 cents to 3.4 cents per 100 pounds?" One answer is, that as far as possible from an engineering standpoint all future warehouses and loft industries must have water-side delivery by lighter canal. As the demand for delivery by lighter grows, "water truckmen" will come to the fore with light and small equipment to take care of small work. The present lightermen will have their own work to do with large units. Agreements should be made whereby they would not quote on less than 50-ton lots.

The water-truckmen will be able to quote lower rates on less than 50-ton lots because of their special equipment for that service.

There must be a ruling that a lighter of more than 100-ton capacity with less than 50 tons of load must not enter a slip to unload except en route. This would force large lighters with small loads to keep out of a congested slip.

There will be no possibility of a new service unless there be an agreement or a ruling to divide the service. No undue taxes, fees, or restrictions should be imposed on such a highly important adjunct to a port as the lighter.

Mr. Bush has well remarked that everything which will move freight, everything which rolls or floats should be at work in a congested port like New York. If this could be accomplished at the port of New York we should have freight leaving a ship or reaching it by several means. There would be cars alongside moving over the belt line to the interior by rail, overside into canal barge for water routes, onto the piers for local delivery by trucks, and overside into lighters for local delivery.

New York Lighterage a Substitute Belt Line.—At the port of New York we find a peculiar condition. San Francisco, on a peninsula with the trunk lines terminating in Oakland, has a considerable similarity to New York. Otherwise the port of New York is absolutely different from other ports. There is no harbor belt line, but there has grown up a substitute for the same which has done very well until the last few years. New York was built on an island. The reason the streets were laid out running close together across the island was, it is said, because it was expected that the north and south traffic would be carried on the North and East rivers. Manhattanville residents formerly went to New York by boat. After the opening of the Erie Canal, it made no difference where the canal barges tied up, at the Jersey shore or at Manhattan Island. Commerce and shipping developed on Manhattan Island under the stimulus of the Erie Canal traffic. When the railroads became a factor they had to compete with the Erie Canal and also were separated from Manhattan Island by the Hudson. It became the practice to lighter freight to any point of the harbor as part of the carriage of freight from the West. The "free lighterage" became the custom and has since so remained. The lighterage is reckoned at three cents per 100 pounds and this is absorbed in the western freight rate. As a result, a ship lying any place around Manhattan Island or the shores of the Bay within certain liberal lighterage limits would be reached by any of the roads entering the city, either on the Jersey side, or from the New York Central, or New Haven, which actually enter the Borough of Manhattan. The harbor waters have afforded the equivalent of a belt line. Complete flexibility and inter-relation are established. Build a pier or a factory anywhere within the lighterage limits of the harbor waters and it immediately becomes accessible to all thirteen railroads entering the port. As long as the lighterage limits remain the same as they are at present, there is little hope of any of the projects at Newark Bay, Jamaica Bay, or Yonkers becoming important outside of those limits. This all sounds very advantageous to the Port of New York. In fact it has been this complete flexibility afforded by "free lighterage" which has made New York a most desirable port in spite of the greater expense. The fact of the coördination accomplished has blinded men to the excessive costs of the system.

One of New York's prominent traffic men, before the I. C. C.,[1] made the statement that the harbor waters of New York made an inner belt line which made this port superior in coördination to any port in the world. He seemed to overlook the fact that other ports have water in them. If other ports have water in the harbor why do they build many miles of belt line tracks? Why do they not lighter everything from one end of the harbor to the other? The answer can not be that the water in the harbor of New York is of a peculiar sort which makes lightering less expensive here than elsewhere, at Montreal or Hamburg or Antwerp. We found that at New Orleans the Public Belt Line Railways delivered a carload at any place in the harbor district for $5.00, formerly for $2.00. It costs the railroads $1.80 per ton or $36.00 for a 20-ton car to deliver from the Jersey meadows to Manhattan. If the delivery of every carload of freight at New York is costing someone seven times as much as the same service at New Orleans or at Montreal there is something wrong with the much admired water-belt-line by lighter at New York. The time has come when we must understand that the National economic loss of the difference between $5.00 and $36.00 for the same service is just as important whether it is absorbed or not. From the shippers' point of view it may be absorbed. From the National economic point of view our international commercial vitality has been decreased by $31.00 the car load on all foreign and domestic commerce passing through the Port of New York. The public always pays the difference in the end. Lightering of railroad freight is an uneconomical duplication, even if it does accomplish the necessary coördination.

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[1] **Lincoln**, testimony in New Jersey Lighterage Case.

The reason it costs more to lighter than to carry by belt line is to be found primarily in the cost of rehandling carload freight. The capital tied up in lighters, car floats, tugs, bridges, and piers, together with their maintenance and crews, may or may not be greater than a similar belt line right of way and equipment. Granted that the two are equal the saving accomplished by moving carload freight without rehandling would be very great.

New York-Manhattan Lighterage.—There is a distinction which must be made for the sake of clarity. When freight is unloaded from a car onto a lighter for further delivery the process is termed lighterage. When cars are pushed onto a car-float and ferried to another point it is called floatage.

At the Port of New York most of the export and import freight is handled by lighter. Most of the domestic freight, the supplies for the industries and the product of the industries of New York City, as well as the supplies for 5,000,000 people, are car-floated. Some 1,500 to 2,000 freight cars are floated over to Manhattan Island and back again every day. About 90% of the freight for Manhattan Island is for consumption on Manhattan Island and not for export.

If New York were not a seaport at all, but on an island in the middle of Lake Cayuga, there would be no essential difference in the congestion of West Street. That condition is purely a local matter and has little to do with foreign commerce of the United States except that New York's misfortune of being on an island makes it necessary to withdraw all that harbor shore from the services of the foreign trade of the United States and devote it to purely local uses. In considering the problem it must not be overlooked that what is termed the lighterage problem of New York does not concern foreign trade so much as domestic trade. The point is illustrated by the statistics of the waterfront occupation by the railroads at Manhattan Island.[1]

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[1] B. F. CRESSON, JR., in the Lighterage Hearings before the I. C. C.

Occupied by	From Pier No. 1 To Pier 48 11,780 ft. 2.23 miles	 To W. 30th St. 3.91 miles
Trans-Atlantic Steamers	1.4%	17.5%
Coastwise Steamers	15.6%	24.3%
Railroads	47.9%	30.0%
Hudson River Boats	5.3%	3.0%
Sound Steamers	10.0%	5.7%
Ferries	10.0%	7.8%
Open Wharfage	4.3%	3.9%
Coal, Ice, Oysters, Dumps, etc.	5.8%	6.9%
Recreation Piers	2.0%	0.1%

Commerce of Sections of the Port of New York.—The general character of the commerce of the Hudson River within the limits of the port is indicated in the following extract from the Annual Report of the Chief of Engineers of the United States Army for 1914 (p. 234):

"The tonnage of the commerce handled in the Hudson River Channel (North River) in 1912, as obtained from the best available information, amounted to about 72,000,000 tons, of which 41,000,000 tons were handled from piers in Manhattan Borough, New York City, and 31,000,000 from piers in New Jersey at and above Jersey City, to Fort Lee.

"As the result of a thorough canvass made in 1914, it appears that the total commerce in 1913, in the section of the Hudson River included in the project for improvement, amounted to 64,517,302 tons, valued at $2,958,075,917.

"Owing to the great variance in the character of the traffic in the North River, and the exceedingly large number of craft of all classes arriving at and departing from the various piers and passing through the channel to points beyond, it is impracticable to secure reliable information on this subject.[1]

Separate statistics of the coastwise trade and intra-harbor traffic are, as stated above, not available.[2] These data are, however, included in general statistics compiled by the United States Army Engineers, which are presented in the following table and show the total volume of commerce passing through the several sections of the port. Doubtless many duplications occur in these compilations because of the great volume of freight interchanged between various sections of the port. It would be inadvisable, therefore, to make a summation of the traffic on the several waterways and regard that as representative of the total commerce of the port. These data are of value only so far as they give a general statistical view of the traffic in the several sections of the port.

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[1] Jones, "Ports of the United States," pp. 91 and 92.

[2] Grosvenor M. Jones, "Ports of the United States."

	In short tons	
Waterways	1913	1914
New York section:		
Hudson River	64,517,302	58,644,614
East River	(*a*)45,331,216	46,553,605
Harlem River	18,313,336	11,577,922
Gowanus Bay	6,651,469	8,159,186
Newtown Creek	5,141,516	4,445,556
Gowanus Canal	3,000,000	(*b*)
Wallabout Channel	1,048,340	990,618
Flushing Bay	917,561	853,714
Jamaica Bay	816,132	768,550
Bronx River	658,473	841,586
Westchester Creek	571,166	589,322
Eastchester Creek	194,956	135,065
New Jersey section:		
Arthur Kill	(*c*)30,525 094	32,140,264
Raritan Bay	6,612,484	6,120,085
Newark Bay	(*d*)2,807,387	4,260,541
Raritan River R.	1,243,923	1,034,853
Elizabeth River	38,716	29,103

Notes on foregoing table:

(*a*) Not including through traffic.

(*b*) Not reported.

(*c*) Data are for 1912. Includes portions of the commerce of the Passaic and other rivers that passed through the Arthur Kill.

When it is remembered that the entire foreign commerce of the Port of New York in 1914 was only about 32,000,000 tons, as compared with more than 100,000,000 tons on the North, East, and Harlem Rivers, it is strikingly evident that the North River Shore is almost entirely taken up with domestic commerce on railroads, coastwise, river, and Sound steamers.

THE HISTORY OF FREE LIGHTERAGE

It was stated above that the history of free lighterage goes back to the days of the Erie Canal. Canal boats delivered to any point on the water-front. When the railroads were built they had to meet the competition of the Erie Canal and deliver to any point in New York, *i.e.*, Manhattan Island, across the wide North River by lighter. In order to meet the competition of the canal and of the New York Central Railroad the roads entering New Jersey brought freight and passengers across to Manhattan Island for the same rate or fare. The lighterage was considered only a continuation of the rail haul. In the early rate adjustments, which have stood for forty years, it was agreed that in pro-rating, the line which performed the New York delivery should be allowed to deduct three cents on the freight originating east of Buffalo-Pittsburgh and 4½ cents on western freight. The figures were arrived at in a bargain between the railroads and Mr. Palmer, of Palmer's Docks (now the Brooklyn Eastern District Terminal)[1] and were considered satisfactory by both parties to the bargain at that time. Since that time the lighterage limits have been extended many miles and the cost of the service has at least doubled. The railroads on the land end have decreased the cost of haul per ton-mile and therefore are able to absorb the increased cost of lighterage. They have no incentive to improve the lighterage conditions, however, if they are losing 2½ cents or more on every 100 pounds in performing the service. They regard lighterage as a necessary evil.

The free lighterage system has grown fast to the railroad service and it seems impossible to operate on the adhesion without killing the entire rate structure. If one tried to separate lighterage service from the through rate the operation might be successful but the patient would die. This statement does not preclude the possibility of the separation of port charges when the United Port of New York-New Jersey on the one hand is a unit under one port authority and the railroads are a unit on the other.

The New Jersey Lighterage Case.[2]—An attempt was made in January, 1917, to separate the lighterage from the New York rate for freight stopping in New Jersey and not requiring lighterage service.[2] The prayer was not allowed by the I. C. C. and the highly artificial and obsolete arrangement still remains. There is no hope of relief from duplication of facilities and equipment and congestion on the waterfront of both sides of the river until some different arrangement has been made. The present competition at the terminals and the present absorption of all cost above an arbitrary amount for lighterage service, must be changed. After following the voluminous hearings of the case, it seems that it would be impossible to divide the port as the New Jersey contention would have done. Neither will the port of New York, including New Jersey, continue to prosper if the present order remains. The solution must be a union lighterage service and a union switching service under one port authority and connecting all parts of the port on equal terms. At New York, owing to its peculiar conditions, the Belt Railroad and the Belt Lighterage must be one organization. The movements of C. L. and L. C. L. at the port would begin at the New Jersey meadows. For the service the Belt Line Company would receive a certain rate. This would be more than the present three cents, but the railroads could well afford to pay more to the belt line because they would save all their equivalent present terminal expenses which are unnecessarily heavy. The belt line could perform the service at a lower rate than the present costs to the individual railroads and to the public.

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[1] IRVING T. BUSH, I. C. C. Lighterage Case hearings.

[2] Hearing, Interstate Commerce Commission's Formal Docket No. 8994. Committee on Ways and Means to prosecute the case of alleged rate and service discrimination at the Port of New York, et. al. against the Baltimore and Ohio Railroad, et. al.

Both sides were wrong and both sides right in the New Jersey Lighterage case. The great hope is in the present tendency toward centralization. The union of the Lighterage and Belt Railroad Company with the United States, New York, and New Jersey as the joint owners and operators is now within the realms of possibility.

Need for Union Lighterage Service.—With eleven out of the thirteen railroads which bring freight to New York City stopping their tracks at the water's edge on the New Jersey side of the Hudson River, much duplication of lighterage equipment and services ensues. Duplication means economic waste. All carload lots of merchandise coming to New York are lightered to the destination anywhere within the lighterage limits by the railroad company as part of the service covered by the freight rate. In the case of an ocean ship the carload of freight is always lightered by the railroad when the goods have been consigned "for export, lighterage free."

Now consider a ship lying at her berth and receiving freight by lighters. Her cargo arrives over all the roads coming to New York in New Jersey, and over the other two. Each railroad company must send the freight alongside by lighter. Usually many of the railroads have only a carload or two for a particular steamer. Only a few tons are loaded onto the deck of a lighter capable of carrying several hundred tons. The entire lighter and tug equipment for several hundred tons is occupied in delivering as little as two or three tons to the steamer. This waste motion is not all. The many lighters clutter the slip, interfere with each other, and the entire time and effort of removing one lighter and setting another must be repeated for every few tons of cargo loaded.

The army transports have made a ruling—not to save lighter equipment, but to avoid congestion and save time—that the railroads shall pool their lighterage service to the government ships and deliver only full lighters to the slips. Otherwise the government will collect freight from the several railroads in its own lighters and deduct the lighterage from the freight rate. This deduction, if placed at the old rate of three cents per 100 pounds, would please the roads and be a loss to the government or to any private firm doing the same thing, because the old lighterage rate does not begin to cover the cost of service. This is placed nearer six cents than three cents at the present time. A system of union lighterage would relieve congestion very materially and expedite loading.

The principle involved is that of useless duplication of service with increasing cost per ton, increasing congestion and the uneconomical employment of a fleet of lighters many times that which is otherwise necessary. At a time when everything that moves is necessary to the transportation of the country, the conditions demand attention.

In order to understand the excessive cost of lightering railroad freight and also to understand what contributes the largest items of expense it will be necessary to analyze some of the figures submitted to the I. C. C. in the Lighterage Case.

Costs of Delivering Railroad Freight at New York.—Cars which are set off in the New Jersey Meadows to await disposition are cut out and placed on a track. When called for they are handled by three or four different switching crews before starting across the Hudson. There are several different combinations of movements to be made.[1]

(*A*) L. C. L. for Manhattan

Cars with less than carload lots are taken from the Meadows consolidation, and make the following movements. (Average 10 tons of freight per car.)

1. Placed at transfer station in Meadows, consolidated, including physical handling.
2. From transfer yard to Jersey City float bridge.
3. Switched from float bridge to float and floated to pier stations in Manhattan.

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[1] MR. RILEY E. WILLIAMS, Consulting Traffic Engineer before the I. C. C.

4. Unloaded at the New York pier (the car remaining on the floats at the pier). Frequent classifying of freight on the pier to be delivered to drays.

5. Rechecked and repiled on the pier. Delivered to drays—delays and extra handling costs.

(*B*) In C. L. Solid cars which come to the New York pier and average 20 tons.

1. Switched to Jersey City transfer bridge	0.10 ton	$2.00 car
2. Car classification for loading to float bridge. Towing to pier station for unloading at any point in the harbor having a float bridge.	0.70	$14.00
3. Moving car from float to pier. Rechecking and delivery to drays and other pier costs	0.45	$9.00
Total	$1.25 ton	$25.00

(*C*) Inbound freight, but not ordered, and left on the New Jersey Meadow yards and awaiting delivery orders, when ordered

1. Moves from the yards to Jersey City piers	0 15 ton
2. Unload to Jersey City pier	0.15
3. When ordered out loaded from pier to car or lighter in Jersey City	0.15
4. Car shifted to float bridge	0.05
5. Floated to Manhattan pier, unloaded and stored Eventually delivered to drays	0.80

$1.30 per ton = $24.00 per car average

(*D*) West bound lighterage freight, C. L.

1. Loaded to lighter at initial point	0.17 ton
2. Lightered to pier in Jersey City. Unloaded onto pier	0.90
	$1.07
If in broken lots L. C. L.	
3. Switched to meadows for consolidation	0.10
4. Handled into consolidated cars for shipment	0.30
Total	$1.47 per ton.

Westbound freight costs 10c more per ton to handle than Eastbound freight.

Broken lots a small per cent. more.

(*E*) Traffic for harbor lighterage delivery.

Cars held in outside yards until ordered	20 ton average.	
1. Move to lighter	0.15 ton	$3.00 per car
2. Unloaded to lighter sorted for delivery	0.25 ton	$5.00 per car
3. Floated to destination unloaded by carrier. Delivered	0.70	$14.00
Total	$1.10 ton	$22.00 per car

These figures include nothing but "payroll expenses" and do not cover interest on investment, capital replacement, depreciation, maintenance, taxes, insurance, pier rentals, etc. Neither do they include damage claims or losses from pilfering.

The expenses of handling freight to Jersey City consignees over spur tracks would be greatly less, not requiring reloading. If the railroad shipment of merchandise be delivered to a freight house in Jersey City it would cost 12 to 15 cents a ton ($2.40 to $3.00 per car). The same would apply to delivery to a factory siding. Unloading of C. L. freight in Jersey is done by the consignee. He backs his dray up to the platform and unloads. The railway furnishes only a checker. The great difference between $3 and $22 or $24 is the advantage of switching over lightering with all the expenses appertaining thereto. However, it must not be concluded that a belt-line connection with Manhattan would save all the difference. The great cost of terminals, rights of way, and property in Manhattan, even when "diluted" over millions of tons of freight handled, would still materially raise the $3 figure.

Empties from Manhattan or Brooklyn are not usually reloaded for the return trip because (1) cars must be cleaned and repaired, (2) they may belong to a foreign line and must be returned to the nearest junction for the home movement, (3) the water movement is irregular in affording facilities for the outward movement of freight, and (4) outgoing freight must be loaded at once when received as there is no place on the piers for transit storage. Therefore the cars for outward freight are set there during the night, long before the cars loaded with incoming freight are received.

The magnitude of the expense of the freight movement to and from New York, and the load on the high cost of living of the consumer may be calculated by taking the above expense per ton or per car and considering that there are about 2,000 cars arriving at Manhattan Island each day. If a saving of $20 per car could be accomplished on 2,000 cars each day for 300 working days the annual saving of the people of New York would be $12,000,000 on inbound freight alone.

Bush Floatage Costs.—Mr. Bush gives the cost of actual floatage from New Jersey to South Brooklyn as 9.16 cents a ton on a movement of 954,000 tons to and from the Bush Terminals during the year. The cost to the Bush Terminals is less than the movement of the railroad floatage to lower Manhattan for several reasons. (1) The Bush floats do not stand all day in the slip acting as a floating car yard, but make three trips instead of one a day. The floats are earning only when acting as ferries for the cars. (2) The Bush floats, because the cars are unloaded, are not platform floats and carry another row of six cars in the center in place of the loading platform, or 18 cars instead of 12. According to Mr. Bush the terminal costs have increased 22 per cent. from 1914 to January, 1917, the cost of labor 35 per cent.

The cost of "terminal service" under the Bush system is illuminating as it is a compromise between the full belt-line service and the present Manhattan methods. That is, the belt railroad is broken by water which is crossed by car ferries or floats but the actual belt-line service is done on land, not on and by car floats.

On a basis of 1,000,000 tons annually floated (1914):

	1914	1916
Total cost including 9.16 cents floatage	49.35	60.53
Total interest	18.0	
Total taxes	4.98	
Total depreciation	3.80	
	76.13 cents per ton	87.31 cents

This is only the expense arising after cars are placed on float at Jersey yards.

Lighterage costs more than car-floating because, as stated, car-floats which act as ferries to connect parts of a belt-line separated by water are performing a belt-line service, *i.e.*, switching loaded cars without rehandling.

Bush Lighterage Costs.—In lighterage the cars are opened and unloaded, just what should be avoided in the case of railroad freight. Only compared to the dray is lighterage highly economical, not compared to the belt-line, remembering always that the discussion involves only railroad freight. The Bush figures for lighterage costs are illuminating as indicative of the lowest possible costs of this service.

LIGHTERAGE DEPARTMENT

Average costs in cents per ton. Four months, January, March, May, July, 1916. 49,274 tons lightered in 4 months.

	Total cost	Cost per ton
Administration	$5,467.50	$0.1110
Depreciation and repairs	5,314.80	0.1079
Manning and watching	6,868.20	0.1394
Towing	4,765.50	0.0967
Loading and unloading	21,774.47	0.4419
Switching	394.60	0.0080
Insurance	3,628.70	0.0736
Supplies for barges	1,082.44	0.0220
Wharfage	253.07	0.0051
Miscellaneous	323.60	0.0066
Total operating cost	49,872.88	1.0122
Chartered barges	1,615.54	0.0328
Interest on investment. $94,665.79 @ 6%	1,893.32	0.0384

It must be evident that railroads with less equipment and freight movement than at the Bush terminals, must sustain heavy losses from the free lighterage service, over and above the prorated three cents and four and one-half cents per 100 pounds. A statement of the B. & O. R. R. on the cost of operating transfers at the Port of New York, bears this out.[1]

Operating revenue	$502,925
June 30, 1909 Operating expenses	$896,438
Loss	393,513
	$570,105
1910	$1,001,797
Loss	431,692
	$541,595
1911	$1,006,225
Loss	$464,630

All these figures prove that the American plan of not separating the terminal charges from the line haul is as bad business as if the hotel included the champagne bill in the room rent. The conclusions of the investigation point unalterably to the system used in England and elsewhere, the separation of the terminal charges from the line haul. This involves a united port and a definite port policy, but with the economies possible with a union port terminal both the railroads and the public would profit.

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[1] New Jersey I. C. C. Lighterage Case.

Mr. Bush said,

> "Whoever furnishes the terminals, whether it be private capital or whether it is railroads, should be paid an amount which will encourage them to provide terminals so that the public may be served, and if they are not paid the terminals naturally will not be provided in as great a quantity as they are really needed and the country as a whole will suffer through the lack of outlet facilities at this port."

The solution is to be found in the union operation of the port and in the separation of terminal charges from the line-haul rate. This will require far reaching coöperation on the part of railroads, express companies, lightermen, and borough, city, state and national governments.

CHAPTER VII

CARTAGE,

DRAYS AND MOTOR TRUCKS.

The cart is a necessary evil, but because of its flexibility it can not be eliminated. However, its uses must be confined to those for which it is the only means of transportation. Nothing should be moved by dray which can be moved by rail or lighter. The appreciation of this axiom will mean that in the future ports, terminals, industrial plants, and warehouses will be planned to reduce dray delivery to a minimum.

In the meantime, what are the conditions and what are the more immediate and available remedies for the present congestion at shipping points and in the city streets? The two important points of congestion are at the railroad freight house or pier on the one hand, and in the crowded streets of the city on the other. In both cases the economic loss is due not so much to the efficiency or lack of efficiency of the vehicle itself as to the amount of time in which the vehicle is not moving. This loss of time is due to inability to expedite the loading and unloading of the vehicle, to congestion delays in the streets and to cross-cartage causing unnecessarily long hauls and duplication.

There are therefore two points of attack, expedition in loading and unloading, and relief of street congestion. Again, the problem of elimination of cross-cartage is largely a railroad problem, just as we have seen with the belt railway, the lighter, and every other feature of port development. This is logical when we remember that the function of the port is to connect land and water carriers. The cartage problem is, however, more than a port problem as such. It is the problem of the modern large city. It is the same in Chicago as in New York, although each city may have its own differences of detail.

As with the lighter, the dray falls into three classes as to ownership and operation. There is the teamster who is a public carrier and offers his services and equipment for hire. There is the private carrier, the team or motor truck which is owned and operated by private business houses. There are, in the third place, the lines of teams hired by the railroads to continue the delivery of freight beyond their tracks. This is a kind of charter business.

In Hoboken the railroads, in normal times, charge three cents per 100 pounds for cartage on C. L. and five cents on L. C. L. lots. This corresponds to the lighterage charge. It does not cover the cost to the railroads of performing the service and the difference must be absorbed by the rail haul.

At New York the charge by the railroads for C. L. delivery by team is four cents per 100 pounds. No L. C. L. delivery is made. The coastwise steamship lines cart freight from the railroads to the steamer and absorb the cartage. This amounts to four cents for C. L. and five cents for L. C. L. freight per 100 pounds. The minimum load is one ton (2,000 pounds). Unloading from railroad car to dray is much less expensive than from pier to dray, which includes trucking about the pier and lifting onto the dray. As with the lightermen, the price is determined by supply and demand.

The usual rates for private teamsters about New York have been from 7 to 10 cents per 100 pounds, but within the past year they have almost doubled. The teamsters have raised their rates 60% because of the time lost at the piers or freight sheds.[1]

Rates are not made on the weight of the load alone. For instance, a Hoboken produce dealer states that on potatoes, turnips, etc., he pays six cents a hundred pounds for a 75-pound bag, eight cents a hundred pounds for a 140-pound bag, and 10 cents for a 180-pound bag. In this case the truckman pays the ferriage to Manhattan. It is a peculiar condition that it is more economical to have the potato yard on the D. L. & W. siding in Hoboken, where the produce is received in bulk in cars and stored on the tracks in the cars at low demurrage rates, than to attempt to have a yard in Manhattan to which the railroad will not deliver in bulk. Here is a case where car delivery to a terminal market or markets in Manhattan would save much economic waste and liberate many cars now held as warehouses on sidings in Hoboken.

It is estimated that about 40,000 vehicles are constantly engaged in trucking to piers and terminals on the lower west side of Manhattan alone. This is because the 3,000,000 people of Manhattan working, manufacturing, and consuming food, clothes, raw materials and all that which goes to make up their work and play, require about 2,000 carloads of freight a day. They send out the vast volume of their finished products, amounting to 10% of the entire manufactured goods of the whole United States, and every bit of it is moved by dray, without any exception worthy of the name. Even large amounts of merchandise, which has no reason for being on Manhattan Island, except that the merchant who buys or sells it lives here, is carted through the congested city streets to some warehouse. If the proper system of waterfront warehouses with freight car sidings from the railroads and the proper opportunities for waterside delivery by lighter were available, only small lots of freight for scattered consignees would require carting. Waterside delivery by side canal is out of the question in rocky Manhattan Island, because of the excessive cost of construction.

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[1] Wm. S. Kallman, N. J. Lighterage Case.

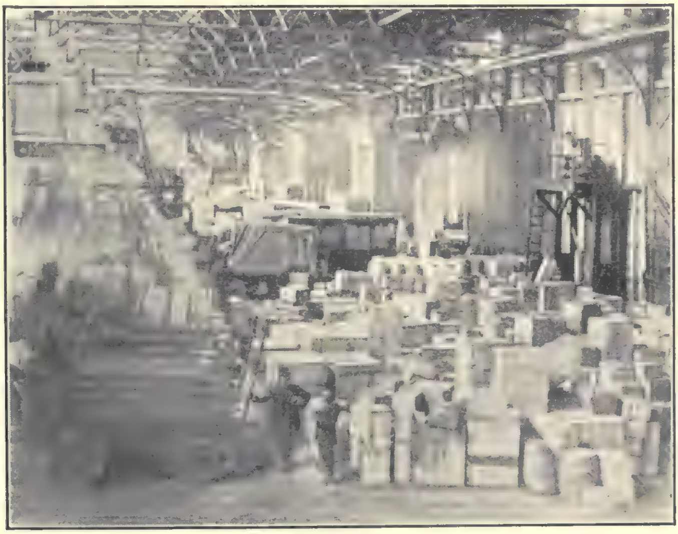

Fig. 27.—A narrow pier has little floor space left after a passage for drays has been made, resulting in much extra handling.

The congestion at the railroad and steamship piers is due to several things: the small size of the piers and the fact that goods must be tiered high and with insufficient aisles to accommodate them. It is then almost impossible to get a consignee's goods out from under or behind the pile when his truckman calls for it (Fig. 27).

The fact that freight cars on a float in the pier slip are presented to the team road end-on increases the difficulty. At the usual terminal freight sheds and team tracks the cars stand alongside a platform which is parallel to the team street and not at right angles to it. Freight can be unloaded and moved a short distance across this platform.

The principal hindrance is the duplication of facilities by many railroads. At New York there are nine railroads on the Jersey City side and at Chicago there are twenty-six roads entering the city. The consensus of opinion during the last few years has been increasingly to the effect that the duplication of terminals of the several roads must give way to union terminal facilities, union lighterage system, union belt lines, and union freight stations, which will serve all roads.

Another cause of congestion is the fact that all the merchants wish to call for or deliver their goods for shipment at about the same time. On West Street, New York, the drays calling for goods arrive after 9:30 A.M. and congestion at the receiving points continues until afternoon. This habit leaves the hours from 7 to 9:30 A.M. almost useless. The receiving stations are closed at 4:30 P.M. The merchant seeks to hold his truck until the last moment to be sure that all that is to be shipped on that day gets off. This practice results in congestion between hours of 3 P.M. and closing time, 4:30 P.M.

Another disadvantage of the present system at New York is that all the railroads, with a few exceptions, have their receiving stations down town. As a result the teams must not only cross the most crowded part of the city to reach the shipping stations, but they must travel many miles.

Cartage Congestion at Chicago.—Freight congestion at Chicago has been even greater than at New York because there were more railroads entering Chicago, because there is no lighterage system or floatage facilities to relieve the congestion, and because 60% of the freight entering Chicago is not intended for Chicago consumers but is in transit to other parts of the country. This requires that the freight be hauled from one railroad company to another. The work of Mr. John F. Wallace and others on this problem has been a great step forward in the terminal situation. The unanimous conclusion of all the students of the problem has been that competition at the terminals between the various carriers must cease and a system of joint terminals must be developed.

Mr. Henry A. Goetz states the case as follows:

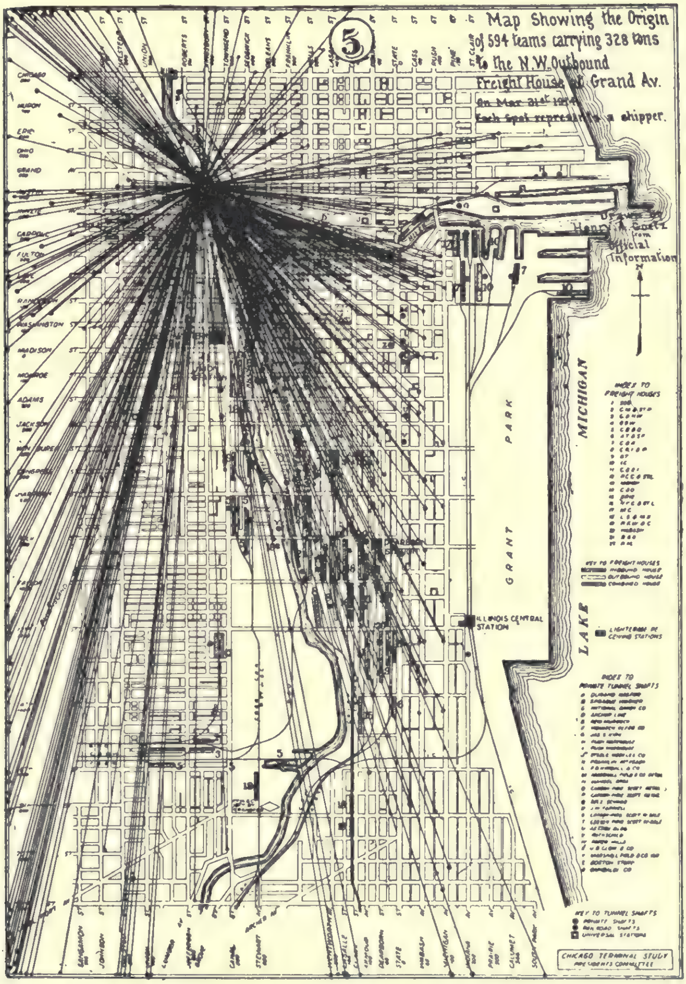
5
Map Showing the Origin of 594 teams carrying 328 tons to the N.W. Outbound Freight House at Grand Av.
On Mar 31st
Each Spot represents a shipper.
Drawn by Henry A. Goetz from Official Information
N
GRANT PARK
LAKE MICHIGAN
ILLINOIS CENTRAL STATION
CHICAGO TERMINAL STUDY PRESIDENTS COMMITTEE

FIG. 28*a*.—The condition. Team deliveries to Northwestern Railway freight house.

"A recent investigation of teaming conditions in the loop showed that on a single day 1,740 tons of 'transfer freight' originating outside of Chicago and destined to points beyond were exchanged by dray between the various downtown freight stations. In connection with the other teaming on the streets, this helps to explain the notorious jam of traffic downtown.

Saving the Team Haul.—"This condition I propose to correct by the establishment of union freight houses to which any shipper may deliver outbound freight intended for any railroad. If a number of the stations were located at the outer limits of the loop the teams instead of going through the loop would be diverted to convenient and selected points on a belt railway outside the business section, thus tending to

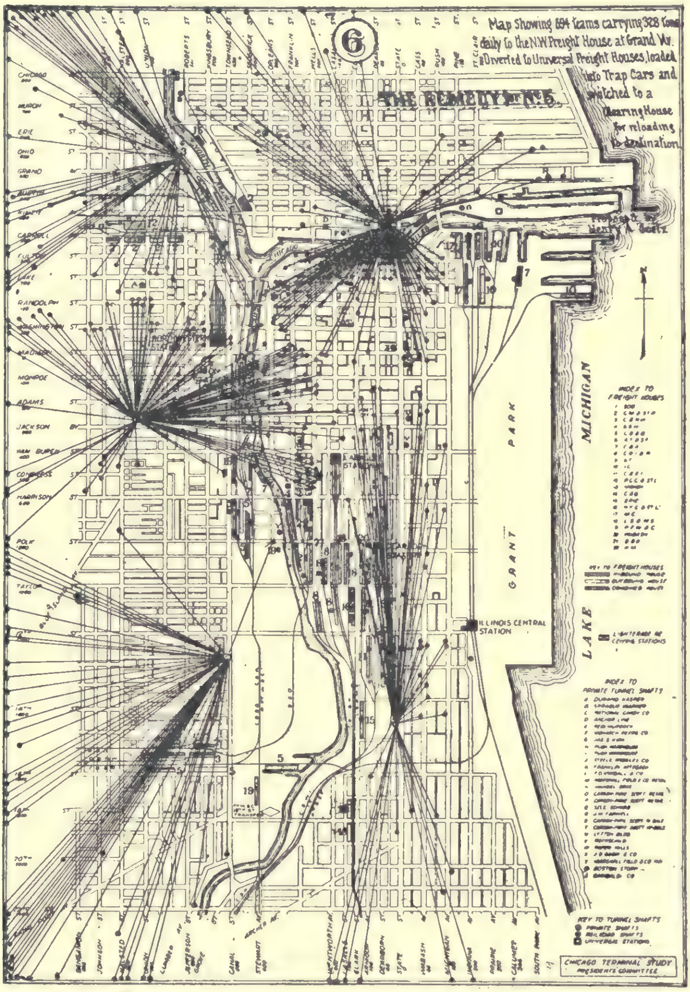

FIG. 28*b*.—The remedy. Same deliveries if made to proposed union freight houses.

prevent congestion and also shortening the haul. Figure 28 shows how the freight deliveries illustrated in Fig. 28*a* would have been made under this proposed system. The short haul will reduce the present excessive drayage expense, for which saving the shipper using these stations should reimburse the railroads by the payment of a service charge, equal to 50% of the saving.

The Clearing Scheme.—"These union stations, however, would be practical and economical only when operated in connection with the clearing house scheme, a coöperative scheme which contemplates, at a point outside the city, an interchange of transfer freight (now brought into the downtown district) on a plan similar to the clearing house of the banks. At this clearing house, each road would have its own setting of cars and its individual platform for out-bound loading; and an overhead transfer platform, reached by elevators able to carry six trailer trucks at one time would afford the means of interchanging shipments between roads and platforms. Here all transfer freight coming from connecting lines would meet the out-bound freight coming from union stations, substations, industries, the river, and the tunnel, and the freight from all these sources would be cleared and loaded into cars in station order for the forwarding road.

"Since October 1, 1915, there has been in operation at Clearing a great hump or classification yard capable of handling 10,000 cars daily. This yard is owned by twelve trunk lines entering Chicago and was organized by Mr. W. H. Lyford, general counsel of the C. & E. I. R. R. It is a "clearing house" for car-load shipments and is operated on a coöperative plan, interest and operating charges being divided among the coöperating roads on a per cent. basis. Mr. Lyford has employed me to promote the handling of less-than-car-load transfer freight at some point outside the city on a somewhat similar plan.

Manufacturing Districts.—"To aid in the up-building of the manufacturing interests of the city there should be defined and located at selected places all over town areas with good switching facilities especially adapted to factories. Maps showing these locations should be prepared and given wide publicity as a guide for industries and an encouragement to such enterprises."[1]

Lessons from the Chicago Situation.—City railroad yards open and at grade are no longer possible as the yards occupy invaluable space and disrupt traffic on the city streets. The extent of this occupation and the Chinese Wall around the business center created thereby is seen at a glance at the map (Fig. 29) of the Arnold report. The only solution is intensive development. The two-level street and the warehouse over the tracks are the coming solution. The two-deck street is also the solution of the heavy teaming question in the neighborhood of the freight stations of the great cities. The electric locomotive has made sub-basement yard switching possible. A good example of the principle of basement car yards and income-bringing superstructures is the Grand Central Passenger Terminal at New York. The commission at Chicago is emphatic that this method

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[1] HENRY A. GOETZ, in *City Club Bulletin.*

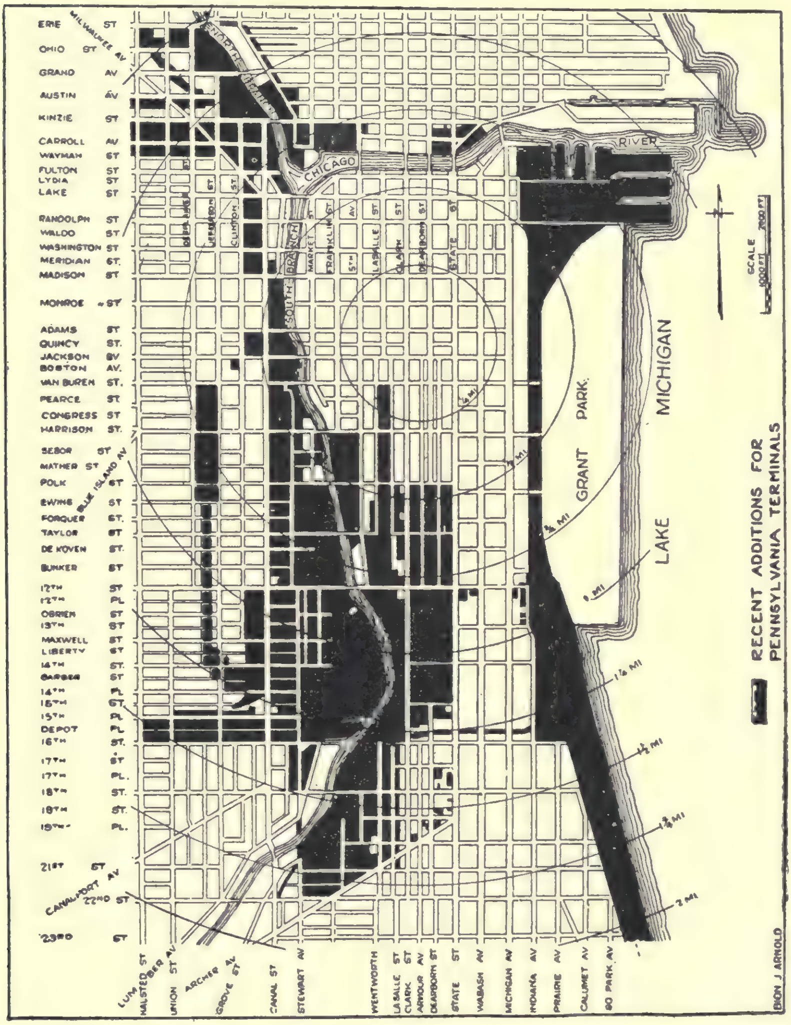

Fig. 29.—Map showing area of steam railroad ownership around business district of Chicago, 1913. (Arnold Railroad Terminal Report.)

must be adopted there. In fact, a large freight terminal is almost completed by the Pennsylvania Railroad at which great warehouses are erected above the two-level freight yard.

The plans of Mr. Goetz to double-deck South Water Street along the Chicago river and apply intensive utilization is an excellent example of the tendency. It is estimated that the reclamation of South Water Street would save the people of Chicago $5,000,000 annually. Half of this saving would be in the decrease in the waste of food-stuffs under the present conditions. South Water Street is the commission and produce merchants' section. The conditions at the neighborhood of Chambers Street and other produce commission merchants' sections in New York are no better than in Chicago.

Markets.—This brings up the question of terminal markets. It is sufficient to say that markets and cold storage warehouses should conform to all the rules of physical coördination of railroads, ships, boats and carts, sheds and warehouses. The same principles are involved in terminal markets as in other freight movements.

Cartage Remedy at NewYork.—The situation at New York is not nearly as difficult to remedy as at Chicago. The ideas of the union terminal system of substations worked out at Chicago are comparatively easy to apply to New York. It is only necessary to consider that the car-float on the various harbor waters when efficiently operated is a substitute for the inner belt line which must be built at Chicago. It has been pointed out above that there has been inefficiency in the car-float (1) where the terminals are operated by each road independently, (2) where the car-floats act as floating car yards, and (3) while acting as car yards the cars are at right angles to the teamway instead of parallel to it which necessitates moving parcels by hand truck along a narrow platform, sometimes 600 feet, to the last car on the last float. A union service with an outer belt line in New Jersey where the necessary consolidation and reclassification could be done would put the Chicago plan into operation at New York at low cost. This is Mr. Bush's plan of union car-float substations distributed at convenient points about the harbor.[1]

The small unit car-float terminals must serve a zone with sufficient freight to support at least one car-float per day to the union float bridge in New Jersey. At present, with terminal competition it would be necessary for each substation to support one float a day to each trunk line, or thirteen times as much. By means of the union belt line and classification yards in the New Jersey Meadows the cars on one float could reach the proper trunk line from the union float bridge. In the early days of the Bush terminal, before the business had grown to a size sufficient to furnish one float each day to each trunk line, there was a loss of $4,000 per month. To avoid this kind of loss by duplication is the aim of the union belt line.

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[1] N. J. Lighterage case.

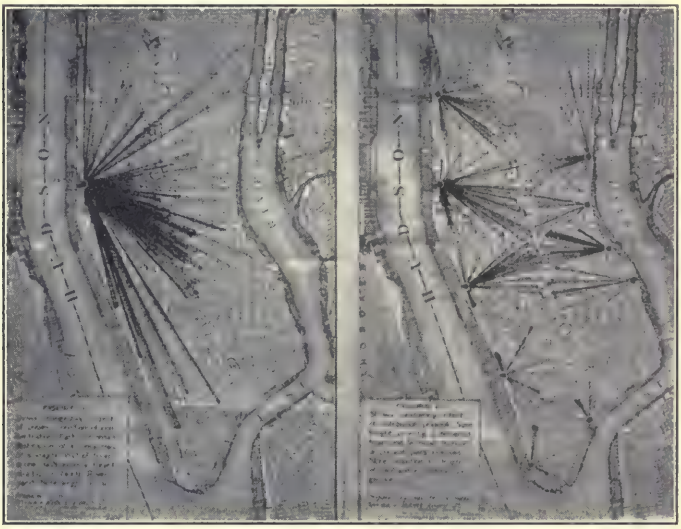

Fig. 30.—Map of dray-mile saving by the sub-station plan.

A substation would consist of a float bridge and upland yards sufficient to accommodate a few sidings and transfer platforms. The small stations in the beginning could get along with platform floats moored in a crib at a bulkhead. The car-float would carry cars for several railroads, perhaps two Penn., two N.Y. Central., one Lehigh, two B. & O., two D. L. & W., etc. Package freight as delivered to the station, would be loaded into the proper car. At closing time the float would be dispatched to the union bridge in Jersey City, pulled ashore and switched to the consolidation yard of the respective railroads. This system would accomplish the double purpose of loading cars full, which at present average only six tons to the car, and also would do away with cross-carting and long hauls.

A graphic representation of what the saving in dray miles per day would mean has been worked out by Mr. R. Rosenbluth of the Institute for Public Service (Fig. 30).

> "The companion sketch shows one of the easy-to-take steps in overcoming congestion, and direct routing, which would also reduce the distance traveled by the same daily team hauls from 1,514 miles to 703 miles. The direct saving would result from shorter haul, quicker moving, and cheaper handling where the congestion is less.
>
> "Many other steps can and would be taken to lessen congestion, obtain better organization, increase flexibility and mobility, and cut costs to a third of present costs for cartage alone—estimated at a minimum of $50,000,000 per year. This has actually been affected in practice by several New York City firms, doing a large business with many branches through the city. Most promising are the possibilities, for example, of the motor truck, provided it is both motoring and trucking, and not standing still, either in a blockade, or waiting to be loaded or unloaded."

The Chicago planners have talked of the union classification yard, the consolidating and transfer stations as one or two in number. This would undoubtedly result in yards and stations of such magnitude that the law of diminishing returns would operate and the institution would defeat its own end. However, it has been pointed out that at Chicago there could be several such yards corresponding to the general direction of the fanning out of the railroad net. The same idea is included in the Bush plan of union car-floats and belt line with reconsolidation of L. C. L. freight at each lines yards in the New Jersey Meadows.

Store-door Delivery.—In addition to the Bush plan of union substations and as the logical development of the idea of relieving congestion by the zoning system, is the *store-door delivery.* In the discussion thus far we have concentrated our attention more or less on shipping rather than receiving freight. The description of the plan of delivering freight from the rail terminals to the consignee may be found well explained by the remarks of Mr. G. F. Hichborn, General Manager of the U. S. Rubber Co., before the New York Traffic Club, March 27, 1917.

He said:

> "The city of New York has spent some $130,000,000 in acquiring waterfront property and improving the same with modern piers and facilities for handling freight. South of Fourteenth Street, on the North

River, practically every pier is occupied by some railroad or steamship company, and the same condition obtains on the East River south of Bleecker street, so that additional facilities in this direction are not procurable. Manhattan real estate is far too valuable to use any large amount of it for railroad yards and freight terminals. We are, therefore, confronted with the question of how best to increase the efficiency of the present terminals, which brings me up to my plan for relief, and that is store-door delivery.

"By this I do not mean to apply the service to all parts of Manhattan, but to the district south of Fourteenth Street, where density of traffic is greatest. Everyone who passes along South Street or West Street, must have been impressed with the large number of trucks carrying from one to ten pieces of merchandise, or about 2 to 25 per cent. of the capacity of the truck. This is an economic waste in itself amounting to thousands of dollars a year. These same trucks, outside of hauling the material, are frequently held in line from one to six hours, the aggregate loss of labor running into many thousands of hours per day. The same condition prevails on incoming freight teams waiting in line to pick up from one to ten pieces of merchandise. The streets of lower Manhattan are already overcrowded with conveyances and pedestrians, so that prompt movement of traffic is greatly retarded. Any plan to reduce team units on the street, should be welcomed by the commercial interests and receive their support.

"The carriers spend large sums of money in handling merchandise two or more times, and tiering it up on their Manhattan piers, besides occupying valuable space for two or more days. Much time and money are wasted in looking for freight when it is once buried behind other freight. Frequently a teamster calling for one or two packages will go away without his goods, owing to the large quantity of freight piled in front of his. The immediate removal of freight would keep the piers open, save damage to articles piled in tiers and reduce pilferage to a minimum, besides increasing by a large per cent. the capacity of the pier for handling freight. It seems to me that any suggestions for increased pier capacity should receive serious consideration from the carrier.

"To my mind the before-mentioned benefits would result from 'store-door delivery' on the part of the carriers. To obtain this end means coöperation and a real coöperation between carriers, trucking, and mercantile interests.

"To inaugurate this twentieth-century service it would be necessary for consignees located south of Fourteenth Street to instruct shippers to consign their goods to a particular pier of delivering carrier nearest their place of business. In addition to showing pier station on bill of ading, shippers should also give the street address of consignee. Freight olicitors would make it a part of their duty to advise concerns upon whom they call as to store-door delivery, etc.

"It would devolve upon carriers to enter into a contract with some responsible trucking concern for handling of freight from piers to consignee's store or warehouse. Carriers would bring merchandise to Manhattan piers, as indicated on bill of lading either by pier station or address shown on billing. The trucking concern doing the transfer work from pier would have that section of the city divided into zones for its trucks. A similar zone section on pier would be defined. All freight unloaded from cars would be sent to the zone section of pier in which consignees are located, and there the zone trucks would receive full loads for delivery. On outgoing freight shippers would have an understanding with trucking concerns to call daily for their shipments, or by some other means as occasion might require.

"By this time I presume some of you are wondering how all this is to work out as regards freight charges, bills of lading, and delivery receipts. Let me offer some thoughts in this direction. I would not impose upon the carrier the additional expense for transfer of goods between terminals of carrier and consignee's place of business. This service should be kept entirely distinct from road-haul charge, which includes only transportation of merchandise between terminals of carrier. Presuming that a large and responsible transfer company would act as agent for the carriers, I believe this transfer service could be performed at a most reasonable charge.

"On the direct-delivery plan, transfer company would represent the carrier. On all freight delivered to transfer company by carrier expense bills would be charged to transfer company, quarterly, per month, and carrier paid as per their statements rendered. Transfer company to attend to the collection of all such freight charges from consignee.

"On all outgoing freight handled by transfer company, that company, as agent for carriers, would sign bill of lading the same as any other railroad agent.

"On outgoing prepaid shipments, where the shipper is on credit list, he should endorse on his bill of lading and shipping order that freight charges are to be prepaid. This information to be supplied on billing to forwarding line; that line in turn would furnish a prepaid expense bill to transfer company, and transfer company would collect from shipper as other freight charges on incoming shipments. Where shipper is not on credit list, freight charges would be collected by transfer company in accordance with established tariff rates, and as per file of tariffs maintained.

"The convenience of this method of handling freight from the terminals of carriers to the store door of consignee, and vice versâ, has been from time to time overlooked by both the railways and the merchants and it is only now when the question of terminal expansions involving an outlay of vast sums of money by the carriers has become of paramount importance that the value of such an arm of the railway service as would be represented by the transfer company could be realized.

"There is little or no need for the opening of new additional freight terminals for less than carload freight in lower Manhattan provided the relationship between the carrier and transfer company was put on a staple time basis so that the transfer company would feel justified in establishing itself on a large scale.

"In certain cities in the United States and Canada, this method is already in vogue, and in London is the universal practice, no railroad being allowed at this time to enter the city of London proper with trucks or maintain depots."

Objections to Store-door Delivery.—The Traffic Club of New York summarizes the objections to "store-door delivery" as follows:

"The successful operation of the plan would require that the receivers accept their freight from any teaming company designated by the carrier. There would be no flexibility in teaming rates, because being a part of the carrier's charges, conforming to the rules of the Interstate Commerce Commission, the present elasticity would disappear.

"Many receivers are located in loft buildings several stories high, necessitating the making of cartage rates on a varying scale in the same district, because it costs more to make delivery to a receiver occupying the top floor of a loft building than it does to a receiver accepting delivery on street level.

"Store-door delivery would seriously interfere with the practice of many receivers who do not want freight consigned to them delivered at their place of business, their custom being to give teamsters instructions, when freight is received at the piers, to make direct delivery to customer's place of business, or to deliver part of the freight direct to customers, another part to warehouse, and still another part to another railroad or steamship line.

"Representatives of large receivers, who operate their own trucks, oppose store-door delivery by carriers because they can do their own cartage work to and from terminals in conjunction with their city work at a less cost than by contracting with a general teaming company. Others opposed it because of the necessity of varying cartage rates from different carriers' terminals to the same consignees; further, certain classes of freight require special handling, such as newspaper in rolls, nursery stock, machinery, glass, textiles, etc. A general teaming company attempting to handle all classes of freight could not do so to advantage either in service or in rates.

"Time and present custom has developed extensive trucking facilities, involving a large investment, which store-door delivery would disrupt.

"Many of the carriers are dependent upon removal from piers of inbound freight to offer proper facilities for the handling of outbound freight. Receivers of freight handled through the piers would materially assist in relieving the present situation by having their freight consigned to a specific pier, and in care of a responsible transfer company, also giving various pier agents instructions that all freight consigned to them should be delivered on arrival to such transfer company. Consignees working under an arrangement of this kind would eliminate the necessity of carriers sending out arrival notices. Such notices or freight bills would be promptly handed to representatives of the designated teaming company, and in many instances, freight would be on its way to consignee before—under present methods—consignee receives notice of arrival."

The Vehicular Tunnel.—The union substation plan has been criticized as inadequate and wasteful of the deep waterfront which rightfully belongs to maritime commerce. An alternative plan, the vehicular tunnel, has been advocated by President Underwood of the Erie R.R., Thomas N. McCarter, President of the Public Service Corporation of New Jersey, and General Goethals. Such a tunnel would cost about $10,000,000. It is entirely feasible from an engineering standpoint. The amount saved to the community from the present impossible waste would more than pay for the tunnel in a year's time. Teams would be excluded and only motor trucks would be allowed to pass. These would drive rapidly to a great union classification and consolidation yard in New Jersey. Almost the entire waterfront of the lower West Side with all its present congestion would thereby be cleared for maritime commerce.

The State of Hamburg has built a tunnel for teams, motors, and pedestrians to connect the town side of the Elbe with the Free Port on the south side of the Elbe where the great quays and shipyards are located. This tunnel is only about half a mile long The length is shortened not only by the fact that the river is not very wide, but to an even greater extent because the tunnel has no ramp approaches. It was impractical to build ramp approaches on the city side because they would have to be very long to reach the low level of the tunnel. The built-up sections of the city as well as the nature of the terrain made the cost of ramp approaches prohibitive. The result was a short tunnel reached by shafts with elevator banks at each end of the pair of tubes (Fig. 31). These shaft houses were equipped with giant Otis heavy-duty elevators whose machines were located above in the shaft house. The two largest elevators in each shaft have a capacity of 22,000 pounds or 140 persons and a rise of about 70 feet at a speed of 160 feet per minute. The point in all this is not only the possibility of the elevator type of tunnel where there is no proper approach, but the fact that with a tunnel haul of less than half a mile and elevator lifts at each end the difference in the speeds of horse-drawn and motor vehicles is not an important factor. When, however, the lordly Hudson is tunneled and provided with ramp approaches where there is a haul of two or three miles the question of the relative speed of the two kinds of vehicles does become a factor to be considered seriously. A pair of tunnels for motor trucks connecting Manhattan with large, roomy, and modern freight yards in New Jersey would undoubtedly relieve much of the present congestion of traffic in the streets and at the terminals in Manhattan.

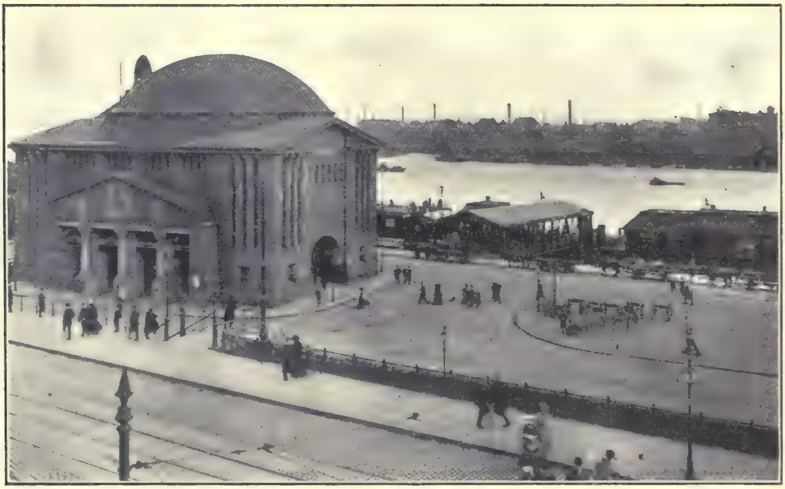

FIG. 31.—Town end of the Elbe Terminal, Hamburg, connecting with the free port. The four entrances to the dray elevators are seen.

The Motor Truck.—The possibility of an economical vehicular tunnel is therefore closely connected with the economical use of the motor truck.

Prof. C. C. Williams has worked out an ingenious formula to ascertain the point beyond which the rail haul is cheaper than the motor truck. The substitutions in the formula of the high terminal expenses of handling L. C. L. freight at the Manhattan terminals would seem to indicate that there would be a saving sufficiently large to amortize the tunnel debt at a rapid rate as well as reduce the expenses to both shipper and common carrier.

Formula[1]

x = distance in miles beyond which R. R. transportation is cheaper.
T = terminal costs in cents per ton for handling freight at origin.
T' = terminal costs in cents per ton for handling freight at destination.
t = costs for loading and unloading motor truck.
c = costs of haulage on R. R.
C = costs of haulage on motor truck.
m = distance in miles of local drayage to and from R. R.

$$T + T' + cx + mC + 2t = t + Cx$$

or

$$x = \frac{C}{C - c}m + \frac{T + T' + t}{C - c}$$

Trucking through freight house 15 cents to 45 cents per ton.
t = 25 cents per ton (average)
C = total costs per ton-mile on truck 14.3 cents.
c = 0.5 cents.

Substituting in the above formula

$$x = \frac{0.143}{0.143 - 0.5}m + \frac{40 + 20 + 25}{0.143 - 0.5} = 1.03m + 6.2$$

$$x = m + 6$$

The question is often asked, "Why are not motor trucks used?" The reason is that the motor truck under present bad loading conditions is less economical than the horse dray. The justification of the greater capital investment is that the motor truck can cover more ground in the same amount of time. If the truck is standing still it is no better than a horse truck. The time lost per day waiting to be loaded and unloaded is about three to four hours. On this basis the annual interest and wages loss on a dray is about $200 and on the more expensive motor truck $480.[2]

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[1] 1917 *Engineering News Record.*

[2] H. L. Whittemore, Feb. 16, 1916, "*International Marine Engineering.*"

The saving in deck space for the year, due to the smaller area of a motor truck, is calculated by one authority[1] at $16.00. It has been estimated by another authority that the saving in pier space by the use of motor trucks is 70 square feet, which with pier rental at 80 cents per square foot, would be a saving of $56.00 per year. The difference is based on the following calculations:

A 5-ton motor truck requires 20 ft. length × 9 ft. roadway = 180 square feet. A 4-ton horse dray requires 25 ft. length × 10 ft. roadway = 250 square feet.

Another way of expressing the advantage of the motor truck as to saving of pier or freight shed room is to put it as a percentage. The use of motor trucks would mean a reduction of 32% of the required cartage space.

The average wait at North River piers is given by Mr. Horine as one hour. Only 58% of all the teams get onto the pier in an hour and some not until after two hours. It has been estimated that Chicago would save $4,300,000 annually by the use of the motor truck for hauling, providing the advantage of the haul was not offset by the loss of time at loading points. The saving in Greater New York would be not less than $5,000,000. Mr. Rosenbluth puts the full expense of carting for New York at $50,000,000 annually. A saving of 10% would be a conservative estimate.

The union cartage idea is not as revolutionary in the ports of other countries as at the present time with us. The privileged or licensed teamsters under the control and jurisdiction of the port authorities are found at many of the greatest ports, notably at the English ports. "The spediteurs" of French and German ports come under the same head. It is quite possible to limit the teamsters by charters which stipulate that they are to conform to certain rules and regulations which the port authorities may deem for the good of the port. This does not eliminate private initiative at all.

It is not necessary to go the full length of union carting and store-door delivery. A teamsters' act would suffice. One of the first things which a teamsters' act would make possible would be the standardization of the cart, in particular the motor truck. It would be possible to introduce movable bodies of a uniform size and design which would make possible the preloading of the bodies and immediate dispatch of the motor truck from the loading platform (Figs. 32, 33).

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[1] M. C. Horine, January, 1916, "*International Marine Engineering.*"

The operation of freight dispatching by removable bodies would follow something like this procedure: Freight cars consigned to the particular zone would come into the station during the night to be unloaded for morning delivery. It makes no material difference just now if this station be pier or platform.

(Courtesy Brown Hoisting Mach. Co.)

FIG. 32.—Illustrating the principle of the removable bodies on wheels, which serve as hand-trucks for short distances, and carried loaded to waiting motor trucks.

The freight is unloaded from the cars onto the small shed trucks or "hand lorries" illustrated in the pictures. One shed truck is one-half or one-third of a load. These platforms are labeled plainly with the mark and name of the consignee. The many small packages for several different consignees may be consolidated for easy delivery into one hand truck according to the proximity of the addresses of the consignees. The shed trucks are then parked two rows to one aisle. When the motor trucks call for the delivery they do not come up to the head house at once, but are met by a "starter" who takes the order for which consignees the motor truck is calling, and gives the driver a call number just as the theatres and hotels do for carriages. The shed truck, loaded, is found on the pier or warehouse or freight shed floor and brought down to the loading platform. The call number is then signalled by the electrical apparatus and with it at the same time the number of the space on the loading platform at which point the dray or motor truck is to back up. The dray backs into position opposite the load to be received. This is then hoisted onto the chassis of the motor truck and it may depart immediately.

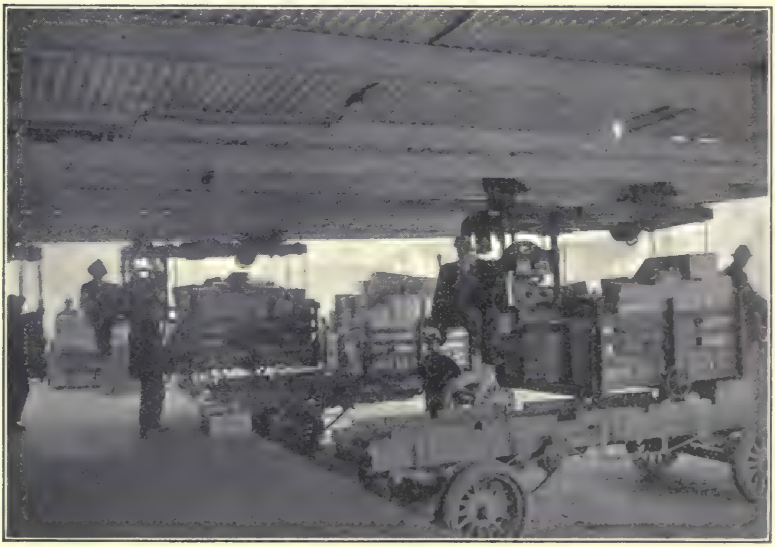

Fig. 33.—The handtrucks, loaded, brought to motor truck by an overhead telpher are set on motor chassis built to take the standardized container truck as one-half of a motor truck body.

There are several things to be considered here. If the private teamster system has been continued there would be a number of half filled truck sections which might have to be consolidated at a point just back of the loading platform at the head-house. On the other hand, if there were a union system of delivery there would be no necessity for the call number as each motor truck would come directly to the loading platform and depart at once to the addresses given by the checker. The movable body system for the motor truck chassis may be carried out under either system and is most promising of successful development.

The question of protection from the weather while in the motor truck is simple. A ridge pole over the load arranged so that it may be quickly dropped into position after the truck is loaded would carry the weight of the large canvas tarpaulin which would be spread over the load.

In case the drays come to a platform parallel with the car tracks it would be a simple matter to push the platform trucks the short distance by hand. When, however, the loading is at the head-house of a pier the long trip down the length of the pier would make a mechanical appliance of some sort economical. This could be either the electrical tractor or the overhead trolley system, known also as the telpher. In either case there would be a track at the head-house extending over the loading spaces with hand or electrical hoists for placing the load onto the chassis. By some such system delay would be eliminated and the economy of the auto truck would be an accomplished fact.

Draying at Liverpool.—Other world ports are not perfect in point of draying or carting. London and Liverpool move most of their freight by carts.

> "While the Mersey Dock Estate possesses over 80 miles of railway tracks around the great docks, it is interesting to note that over 90% of the traffic of the port is handled to and from the ships and warehouses in horse-drawn drays or 'lorries.' From early morning till late at night there is one continuous procession of these four-wheeled, heavily laden drays traveling along the border highway of the great estate. The platform bodies project over the wheels, giving a large loading surface. The horses are powerful beasts, and are usually hitched up in tandem style with from one to three horses to each dray. It is said that some of these powerful Clydesdale horses draw loads of ten tons each, over the Liverpool pavements. This requires, especially on the heavy traffic streets, surfaces which are hard and durable with low tractive resistance and good foothold for the horses. Most of the pavements on such streets are of granite or the famous Liverpool stone sets (small cubes of granite or whinstone from three to six inches square on each surface)."[1]

Resumé.—We should not argue against reforms in America by pointing to Liverpool's misfortune. Perhaps it is this dependence on cartage which has developed in England the system of store-door delivery, an institution of promise in America. The question of cartage is a railroad question and can have a satisfactory solution only when the competition at the terminals is superseded by a union freight service. This requires pooling of terminal service with many substations serving different zones of the city and connected by belt lines both on land and on water. The substations will take the teaming out of the congested parts of the city and will also shorten the team haul.

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[1] *Report of Connecticut Rivers and Harbors Commission* for 1910.

The expedition of teams or drays at the freight station must be improved by such means as will make it possible to avoid long waits and thus make the auto trucks economical. The combination of hand truck and removable body system with power and hand traction and mechanical hoists, together with a carriage call system should remove the waiting at the freight shed.

Wherever possible, carloads should move to warehouses or freight shed or industry siding without unloading. Wherever possible, broken lots as well as larger quantities should move by lighters rather than by any sort of carting. Private trucking should not be abolished, at least not for the present, but all trucking should be regulated. There will always be trucking, yet nothing should be trucked which can be moved by rail or lighter.

Gradually the warehouse and manufacturing establishments must be located with rail and water siding to afford both lighter and car service. Add to this mechanical equipment for the quick dispatch of motor trucks, and the ideal of freight handling efficiency will be accomplished in city deliveries. Such efficiency applies alike to rail and to water-borne commerce.

CHAPTER VIII

I. PIERS, WHARVES, AND QUAYS

ENGINEERING FEATURES

The pier, wharf, or quay is an artificial structure in water deep enough to permit vessels to tie up against it and load or discharge cargo. The function of this structure, which may be any one of the three types mentioned in Chapter III, is to afford direct connection between the water carrier and the land with its many vehicles. The wharf is the point of contact between water and land carriers.

The equipment of the landing stage consists of many elements. There may be cranes, cargo masts, conveyors, or other mechanical means of transferring the cargo from ships' hold to wharf or there may be no equipment whatsoever, the tackle of the ship being the main reliance. Then there may be various means of moving the freight along the pier and away from the pier to the consignees. This may be accomplished by means of hand trucks, electric trucks, telphers, drays, railroad cars, and other devices. However, the most important equipment is the transit shed to protect cargo held temporarily on the wharf in transit between ship and shore. The nature, function, and arrangement of these various elements of the well-equipped wharf must be studied in detail and in their relation one to the other. We are now ready to study the wharf in the light of the general knowledge of land vehicles of the preceding chapters.

The wharf or pier in itself is an engineering problem. Before considering the economics of wharf design there must be some understanding of the technical difficulties which the engineers who carry out the design will probably encounter.

Wharf Design.—The port planner must work in close harmony with the engineer. It is most essential that the port planner have a fair knowledge of the technical problems of pier and wharf construction because the economic advantages of this or that layout or general plan may have to give way to considerations of construction. Therefore, just as it is impossible for engineers to lay out a successful port considering only the technical problems of construction, so also must the engineer-economist consider technical questions.

There are several publications to be recommended to the student of port planning. (1) The comprehensive two-volume work by Cunningham, an English engineer, which deals with the entire engineering problem of harbor works. (2) An excellent little volume, "*Wharves and Piers*" by Carleton Greene, published by the McGraw-Hill Book Co., New York, 1917. This presentation is not too technical in phraseology and should be readily understood by the layman. (3) "*Seehafenbau,*" F. W. Schulze, Berlin, Ernst & Sohn, 1913. (4) "*Subaqueous Foundations,*" Fowler.

Therefore, with the technical side of pier and harbor construction well presented by several authorities, and easily accessible, it will be necessary here only to outline a few general points which must be borne in mind while considering the economic side of the problem.

Unfortunately there has been no uniformity in terminology and much confusion has arisen. It is the duty of all port students to insist on the use of the proper terms. Otherwise it will be difficult to discuss the various problems of the subject with the assurance that one is correctly understood.

For the purpose of our discussion we shall use the word "pier" for a structure extending into the water, and "wharf" for a marginal landing stage or for any landing whatsoever. Sometimes the term quay-wall will be used. The fact remains the same, that piers may be either built on piles, or filled, and the same applies to wharves. The word "quay" usually conveys to the mind a picture of a solid wall with solid fill behind it.

The wharf structures surrounding docks or tidal basins in European ports are usually of filled structure while the wharves along levees or rivers in this country are at least partly of pile construction. It is evident that the strips of filled and walled land between two basins or docks in many European ports are nothing more than gigantic filled piers several thousand feet long and several hundred feet wide. This fact, that the large excavated basins are only the intervals between large piers of solid construction brings out the first axiom of wharf construction.

The longer the pier the wider it must be and the wider the water basin or slip separating it from the next pier.

The reason for the narrow pier is historical. The city or state had title to land under water at the extension of the streets and the pier was therefore no wider than the streets of which it was an extension. The piers were large enough for the ships at the time they were built. This is no reason for retaining the narrow pier system for the modern large ships.

When piers and when quays and when marginal wharves are to be used is a matter of circumstances.

If a river is narrow only wharves can be used. When the capacity of the wharves has been reached, there is nothing left to do but dig into the shore. If the land is low and soft there should be no difficulty in this. Practice in the past points to the preference for the long, wide basins with solid-fill quays. If the land out of which a basin is to be dug is low the spoil from the excavations will be most cheaply disposed of as fillings. (Refer to port maps in Chapter III.)

If a river is wide enough the pier construction as we know it in New York is the most economical waterfront.

"For example, a marginal wharf 2,000 feet long will accommodate only four 500-foot ships, but on such a property may be built five piers, each 1,000 feet long and 150 feet wide with slips 250 wide between them, which would provide berthing space for twenty ships."[1] This is true enough. The danger lies in looking at this one point of waterfront economy to the exclusion of other features, such as the necessary equipment and the entire problem of economy in time and labor in freight handling. These points must be balanced against each other.

Before discussing this parallelogram of forces in pier efficiency it is necessary to review some structural data.

For both marginal wharves and piers there are two types of construction, *the pile structure* and *the solid fill.* In most cases the cheapest form of construction is the wooden pile. Pile structures may carry greater weight than filled structures when the bottom is of loose mud. With a loose mud bottom the filling acts only as an additional load and is a detriment rather than an advantage.

Where the wharf is wider than 250 feet the filled structure is more economical and, if the bottom warrants it, more permanent. Where the water is infested by teredo, limnoria, and other marine borers, the solid fill becomes almost a necessity. It is possible to encase the piles in a concrete shell. Creosoting is little protection against the destructive animals because they usually find some avenue of entry. The filled structure with only the outside rows exposed and accessible for renewal is necessary. This construction is possible at low cost where the slip dredgings may be used for the purpose.

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[1] GREENE, "Wharves and Piers."

Pile construction, where the marine borers are not present, in water full of sewage and in northern waters, is remarkably permanent. Wooden piles when constantly submerged are practically immune to decay. This condition may be maintained to a height of the mean between high and low tide. Up to that point it is possible for the pile to remain always wet. Air, heat, and moisture are necessary for the decay of wood. Where the air is shut out by water, the decay is very slow.

Pile construction has several advantages other than simple cheapness.

1. A pile structure does not materially reduce the tidal prism. That is, it does not affect materially the amount of water which flows through its channels into and out of the harbor with the changes of tide.

2. Pile wharves are more elastic. The kinetic energy of a ship moving at a speed of one mile an hour or 1½ feet per second is 350 foot-tons and twice this speed 1,500 foot-tons.[1] This energy must be absorbed in some manner or it acts as a destructive force of that amount to both pier and ship. Ships will shun a wharf that puts all the destructive force of impact onto the ship. An elastic pile structure absorbs this energy. With other kinds of solid structure fenders must be provided, such as buffers made of faggots, rope, or timber and springs.

As piles below the waterline are practically immune to decay the more recent practice has been to cut off the piles at low water and cap them with concrete.

There have been many failures of concrete in subaqueous construction. It has been found that when concrete has been cast on shore and allowed to harden or set before coming into contact with the water this concrete has held. The latest form of concrete cap to pile structures as developed at the Brooklyn Navy Yard and adopted at some of the Barge Canal terminals takes this fact into account. Reinforced concrete columns in "T" form with the iron rods projecting from the arms of the "T" in hooks are cast on shore and allowed to set. The piles are cut off a little above low water and the set "T" fastened onto the ends of the piles, usually to pile clusters. The "T" arms are then connected and formed into the regular reinforced concrete beams by the usual method of casting on the job. A concrete floor or pier deck is laid over this and faced with 1½-inch asphalt to give a better wearing surface. The life of these piers will be followed with interest as time passes.

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[1] CARLETON GREENE, "Wharves and Piers."

The pile construction has become more difficult and expensive owing to the lack of good piling. The all-water-via-Panama-Canal-route will make Douglas fir in 120-foot lengths available on the Atlantic Coast. This is the best timber for such construction.

The depth of water must be considered where piles are used. Where the depth of water does not exceed 25 feet, the bearing power of 14-inch to 16-inch wooden piling is 12 to 15 tons. Piles should be crossbraced as far down as possible. A drawback to the use of concrete piles is the difficulty of crossbracing. The deflection of an unbraced pile is that of a cantilever beam and varies as the cube of its unsupported length.

In mud bottom the bearing power of a pile foundation is obtained by finding the skin friction of test piles. The kind of bottom available is most important in the choice of the entire layout, even to the size of the pier and the freight handling installations it will carry.

3. The third chief advantage of pile structures is cheapness and rapidity of construction as compared with filled structures which require considerable time to settle.

A new pier nearing completion in Philadelphia, one of the Moyamensing group of municipal port extensions, is an excellent example of the pile and solid fill types of pier construction. The width of the pier makes open piling disadvantageous. The pier is described as follows:

> "The substructure of this pier was designed on the solid fill type, which may be briefly described as consisting of solid earth fill retained by piles, timber and concrete bulkhead construction about 25 feet in width (sometimes called a wharf apron) forming the sides and outshore ends of the pier, the solid land of the inshore end constituting the closing side. Pile, timber, and concrete foundations are provided for the intermediate columns and the concrete retaining walls of the side constructions above low water are tied together across the full

width of the pier and at the ends by concrete encased steel ties, to withstand the horizontal thrust of the filling retained within the enclosed area by the sheet piling driven along the back or inside of the bulkhead, under the concrete retaining wall construction."[1]

Of the photographs Fig. 34 shows the driving of the sheet piling of the 25-foot apron. Fig. 35 shows the forms for the concrete column pedestals which are placed on pile clusters cut off at low water. The concrete coated I-beam stringers which tie the pier together laterally are plainly visible. Fig. 36 shows the retaining wall of concrete placed on piles cut off at low water, the lateral ties and the column pedestals. Fig. 37 shows the method of filling from lighters by means of twirler crane and bucket to skip cars on a temporary movable bridge.

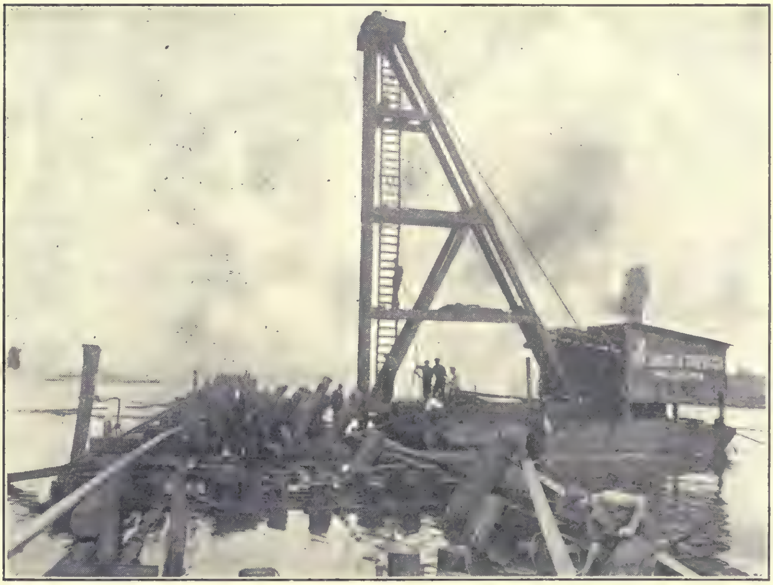


Fig. 34.—Pier No. 78 South Delaware Wharves. View showing the driving of sheet piling.

Life of Structure and Obsolescence.—From the viewpoint of financial efficiency, cheapness of construction as well as speed of construction is important. In every commercial center there are unforeseen events which may lead to a complete change of conditions. It is therefore seldom advisable to make the total first cost very large by installing works with a longer life than half a cen-

[1] *Annual Report Department of Wharves, Docks, and Ferries,* 1916.

tury, or even 25 years. In European ports where the entire port is a municipal or government institution, harbor works have been built to last centuries. There is no doubt that they are cheaper in the long run, and require smaller annual amortization and depreciation than a pile structure, because the period of amortization is longer and the structure more durable. That is, if the life of the installation is calculated for over 50 years the depreciation will be 2% per annum. If the life of the pier is calculated for 25 years the depreciation is 4%. The annual percentage of income from the pier which must be written off as the replacement of capital is twice as large, in the case of a 25-year structure as against one with 50 or more years of life. However, if the original investment of the pile structure with its light superstructure is only half that of the expensive wall-and-fill, then the actual annual replacement fund in cash is the same amount in both cases, 2% of $1,000,000 for 50 years, or 4% of $500,000 for 25 years.

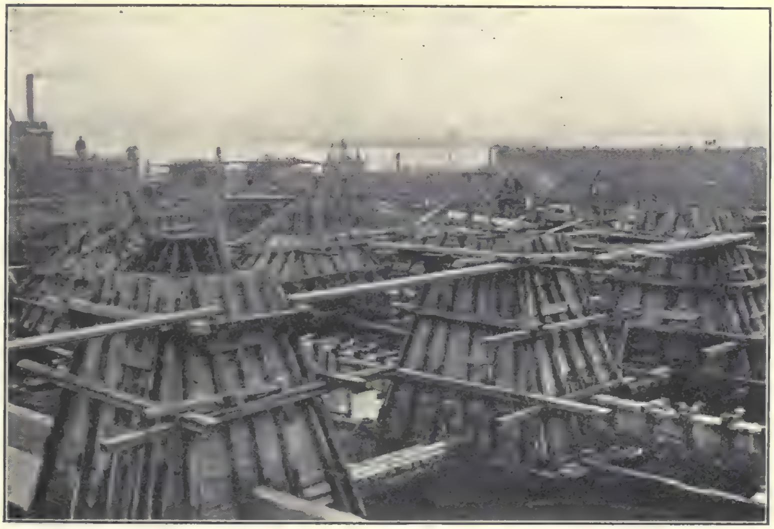


Fig. 35.—Showing column foundations, outer end, looking northwest and forms for wall on outer end.

The difference comes in *the degree of obsolescence* at the expiration of the 25-year or the 50-year period. It is not always possible to calculate in advance the changes in the size of ships and the methods or location of doing business which may take place during the years of the life of the pier. In American ports at the present time, all prophecy is hazardous and a pier with a long life and high initial cost may become obsolete long before it has paid for itself.

Fire Risk.—Wooden piers are a great fire risk. The usual risk to the pier is from burning oil, cotton, or wreckage from ships burning in the vicinity. When such fire brands are carried under the pier there is little hope of saving it unless the pier be of the U. S. N. concrete cap and deck construction just described. It is always advisable to enclose the pier with planking to prevent firebrands, wreckage, driftwood, small boats, lighters, etc., from floating under the pier deck. At the same time ample ventilation must be arranged to prevent mold and decay. It is well to provide foot platforms under the deck to permit of easy inspection of the substructures.

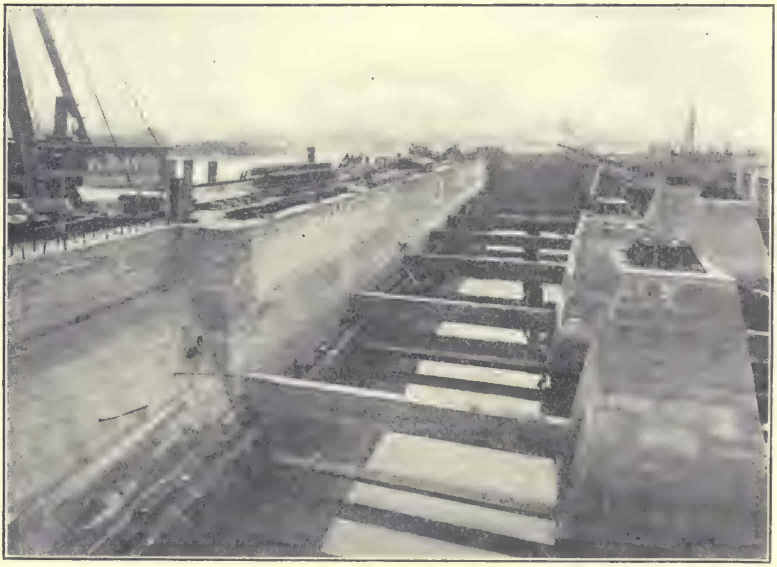


Fig. 36.—Pier 78 South Delaware Wharves. North side, looking east, showing wall, sheet piling, cross ties and column pedestals.

The best safeguard against fire from floating brands and oil is to have the port laid out properly in the beginning with a petroleum harbor separated from the rest of the port by watergates. Cotton, as far as possible, should be segregated, as also explosives. Flour mills and grain elevators are also heavy fire risks and should have their own sections of the port if possible.

As to the superstructure, the shed frame work, the latest efforts have developed a system of concrete-coated steel construction. The structural steel collapses in 15 minutes in the case of a full fledged fire. To give greater resistance the usual structural steel frames are covered with wire lath and trowel-coated with concrete. The result is a light, fire-resisting frame. Wire glass and also fire doors should always be used for partitions in spite of the protests made by most pier superintendents. The best fire-resisting roofing is tar and gravel. A gratifying increase is to be observed in the use of automatic alarms and sprinkler systems. However, this protection becomes illusory in freezing weather. The fire on a pier usually destroys the superstructure and the cargo, often worth more than the pier, but the foundation, the piles and deck are often uninjured. The superstructure is therefore the place of greatest fire risk. However, a pile pier of the Pennsylvania R. R. near the new Moyamensing group at Philadelphia recently burned to the water's edge.

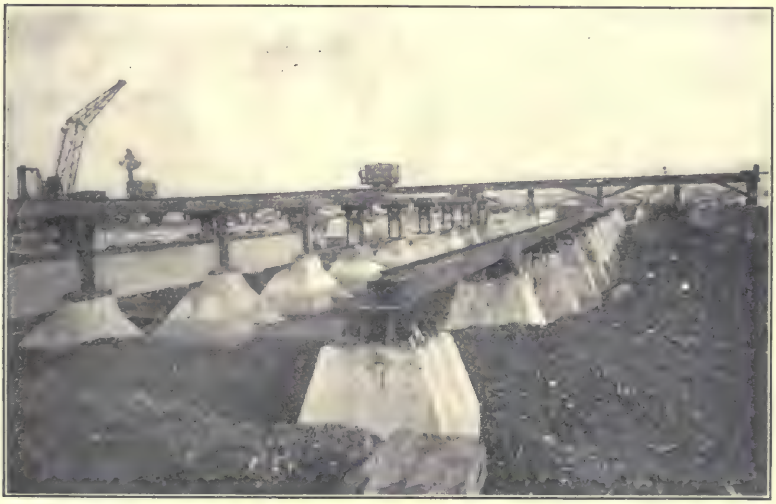


Fig. 37.—Pier 78 south; center of pier looking east, showing earth fill, etc.

The true basis of pier construction is the determination, as far as possible, of *the nature of the freight movement which the pier must mediate.* The kind of a pier which is required for the place where it is built will depend upon the local physical conditions of the site, but above all upon the equipment which will be put upon the pier.

CHAPTER IX

WHARF EQUIPMENT

The transit shed is the first and most important item of wharf equipment. At New York and elsewhere the shed is limited in dimensions by the size of the pier. There is little choice in the size and proportions of the pier transit shed. The result has been that the pier and the pier shed have been considered as one and the same institution. This is not the case in theory, and in other ports with greater freedom of action is not the case even in practice. The transit shed is a thing apart.

The function of the transit shed must be kept clearly in mind. The transit shed is a covered structure to give protection from weather and pilfering to a cargo in transit between ship and land. When a ship makes port, it must discharge its cargo as rapidly as possible and can not wait with this unloading to allow the cargo to be taken away. The cargo must also be spread out to afford opportunity to sort it according to marks and consignees. During this time, from the discharge from the ship until the goods are sorted and moved away, they must be protected. Likewise in loading, when a ship arrives and has its cargo all out it must load the outgoing cargo as rapidly as possible. This is only possible if the cargo has been assembled beforehand and sorted according to ports of destination and nature of the goods. The stevedores can work rapidly and load correctly only when the cargo can be loaded and stowed in the proper sequence. Stowing according to port of destination is very important when the ship is to call at several ports, as for instance on a voyage to South America.

Size of the Transit Shed.—It follows from the foregoing that a transit shed must be sufficiently large in area to hold the cargo of the largest ship using the landing, and in addition to hold it spread out for sorting with aisles between the piles of cargo at frequent intervals. The cargo must have space enough without the need of piling it more than shoulder high as this piling or tiering is very expensive and time consuming. Goods may be tiered in a warehouse but should not need to be tiered for the two or three days that they a e in the transit shed. The transit shed must have an unbroken floor space sufficient in area to perform this service of smooth stevedoring without congestion.

What is a sufficient area? One way to get at the answer is to consider the latest practice at some of the best ports abroad, where there has been sufficient room to build sheds the size wanted without being limited by the size of the pier. As first example may be noted one of the latest quays[1] in Hamburg with three sheds of a combined length of 965 meters and width of 42 meters, or 40,523 square meters. This would mean a length of sheds of about 3,210 feet (1,070 feet to each shed) and a width of 140 feet, or nearly 450,000 square feet of space. The quay wall is 1,090 meters or 3,610 feet long, 400 feet longer than the combined length of the sheds. This would give an area of 150,000 square feet for each shed. Assuming an average required capacity for 15,000 tons of cargo to each shed the allowance made is 10 square feet per cargo ton. The area may have been calculated at one square meter (1.196 square yards) per cargo ton for a somewhat smaller average cargo. Such a quay would accommodate six 12,000-ton gross (B. R. T.) steamers as to length, but when the quay is full there would be an accommodation of only half a shed for each steamer. A cargo ton measurement is 40 cubic feet (2.83 cubic meters). Ten square feet would accommodate one cargo ton piled four feet high. At this calculation it would be necessary to tier above four feet to make the aisles, otherwise the 15,000-ton measurement of cargo would completely cover the shed floor at an average height of four feet. At Bremen the tendency has been to shorten the sheds and increase the depth. The first sheds to be built in the "free zone" were 40 meters deep while the later sheds are 66 meters deep. The latest Bremen sheds are 216×640 feet, which gives an area of about 140,000 square feet. This is a smaller capacity than that of the Hamburg sheds, yet, still assuming 10 square feet per ton of cargo, the shed would accommodate 14,000 tons. As this is about the limit of cargo capacity of ships coming to the port of Bremen (the very large steamers all dock at Bremerhaven) the accommodation for cargo calculated on the above basis is sufficient.

An important feature of the increase in the size of the sheds

[1] Augusta Victoria Quay, opened 1903.

is that the only way to keep pace with the size of the ships is to increase the depth of the sheds. Granted that sheds should be as long, or nearly as long, as the longest ship using the berth, a simple increase in the length of the shed will not afford sufficient space on the shed floor to accommodate the increase in the size of the cargo. When a ship's size is increased it is in linear measure, but the cargo capacity at the same time is increasing in cubic measure while the shed floor is only increasing in square measure. A ship 500 feet long is 25% longer than a ship 400 feet long, but the increase in cargo capacity will be considerably more than 25%. To accommodate the increase in the capacity of ships it is necessary to increase the length of sheds, but the depth must be increased even more. This fact accounts for the pier congestion at New York, where it has been possible to increase only the length and not the depth, *i.e.*, width, of the pier and its shed.

Recent New York practice, as found at the Chelsea piers, is to make the shed a little less than 120 feet wide and about 900 feet long (the pier deck is 1,000 feet in length), or an area of about 100,000 square feet. This would afford a capacity of 10,000 tons of cargo. However, the Chelsea piers are of two stories and the Hamburg sheds of one. At Hamburg it is the custom to move the ship from the discharging to the outgoing shed. Granted that both decks of the Chelsea pier shed are used for freight, the upper for outgoing and the lower for incoming freight, which is not always the case, the shed space is about two-thirds that of the Hamburg shed. It is confusing for a moment that the two-story shed does not make a total area of 200,000 square feet at the Chelsea piers as against 150,000 square feet at the Hamburg, or 140,000 square feet at the Bremen shed. The joker is found in the practice at the two Hanseatic ports of using different sheds for incoming and outgoing freight to avoid any possibility of confusion. Rather than warp the steamer across the slip or basin, the American practice has been to build double-decked sheds with the upper deck for incoming freight and the lower floor for outgoing freight. Such a pier shed is a more intensive use of the waterfront, but the cargo can not be moved so easily. On the other hand, it is easier to move a ship in the European basins because of less current and easier angles.

One of the best American authorities on ports, Mr. McL. Harding, President of the Society of Terminal Engineers, has worked out another theory of pier transit-shed size. As this was received later than the writing of the above and as it represents an absolutely independent calculation it is given here in full.

Harding's Calculation of Shed Capacity.—"It is a good rule to plan the shed for such a capacity that it will be possible to distribute all the goods taken from one ship berthed opposite to it. This is the rule at Hamburg, Germany.

"When goods are handled by hand, the average height of tiering or piling is about five feet. It is, therefore, evident that there would be required a very large floor area to distribute and place a cargo of 6,000 tons according to the marks and cross-marks, especially in a miscellaneous cargo.

"Assuming 60 cubic feet, instead of the marine 40 cubic feet, to represent the volume of one ton and 16% more for distributing space, this would equal about 70 cubic feet per ton. Six thousand tons would, therefore, represent a cubical content of 420,000 cubic feet, and, at an average height of five feet, would cover a space of 84,000 square feet.

"The reason for the five-foot height for average tiering is that manual lifting above this height means a considerable increase in the handling expense. It is more economical to hand-truck 400 feet than to lift 10 feet by man power. By mechanical tiering, freight can be tiered 20 or even 30 feet with little, if any, additional expense over tiering five feet.

"Assuming an average height of tiering at 15 feet, a building could be made 56 feet in width, 500 feet in length, and yet have a capacity on the above basis of 6,000 tons, at 70 cubic feet per ton. In order to allow even more floor space for the distributing or a greater holding-shed capacity, 20 feet may be taken as an average tiering height. A shed, therefore, 60 feet wide, 500 feet long and with a clear height below the girders of 30 feet, tiering 20 feet, would accommodate 8,500 tons, allowing 70 cubic feet per ton. This, or a shed 400 feet in length, would be a properly proportioned shed for inland river terminals.

"It is interesting to note that 60 feet is the standard width of inbound railway freight stations.

"If the width of the sheds can be kept within the above limits, the cost of the shed will be less than is usual, as there will be one short span only and no intermediate posts to interfere with the freight movements, which posts should be avoided if possible.

"It is evident that capacity is secured by height and not by width."

There is one point in which this calculation is open to attack. It is possible to tier standard packages such as bags, bales, and crates of uniform size by well known mechanical means at low expense. However, it is hardly possible to tier general cargo of all sorts and shapes of parcels except at great expense. Also, it is very difficult to handle small general cargo shipments to scattered consignees when the goods have been tiered. It would therefore seem that, except at wharves handling standardized cargo such as cotton or sugar or coffee in shipload lots for certain large consignees, it would be necessary to build sheds with a large unbroken surface to take the cargo of the usual line traffic spread out and not tiered.

Unbroken Floor Space.—Much of the confusion concerning piers layouts will be avoided by keeping firmly in mind the fact that the pier shed floor as calculated above does not include space for railroad tracks or teamways. The shed is a thing in itself and the relation of cranes, teamways, or railroad tracks to pier design or wharf layout is as an additional part of the equipment and not as part of the shed.

Railroad Freight.—Consider the movement of railroad freight. This constitutes from 50 to 75 per cent. of all the freight movement of most ports serving a prosperous hinterland. In the case of the quay system the spur tracks of the harbor belt railway are the side of the transit shed opposite the steamer. As freight is unloaded onto the deck of the shed it is stored, and as rapidly as cars are available for the shipment the goods are trucked in a more or less straight line across the pier to the cars and loaded. It is seldom very straight across as the particular car wanted is seldom set directly opposite the particular goods to be loaded. However, as far as possible the movement is across the shed in the shortest possible line.

In case of the narrow piers at New York the same railroad freight is trucked more or less straight across the pier deck to the lighter which is the substitute for the harbor belt railroad at New York. It would be impossible to berth on each side of the pier at the same time as the piers do not hold the cargo of one ship as it is. In the case either of the belt line or the lighter the movement across the deck from unloading ship to waiting car or lighter is the shortest possible and most efficient one.

Car Tracks.—The great controversy concerning the placing of car tracks on piers which has aroused so much debate is due to a confusion of very simple principles. In the first place, the idea of putting car tracks down the center of a transit shed located on a narrow pier which, owing to the small width of the pier, is already of insufficient area, is out of the question. They are more in the way than serviceable. Then also, if the car tracks do not go to any place, as at New York, they serve no purpose. As long as lighters are doing the belt-line service there is no reason for the car tracks.

Much effort has been made to befog the issue of car to ship delivery by stating that the ship can not be loaded from the railroad car. Certain individuals and certain daily papers which should have known better harp on this perfectly true statement. No one loads freight from car to ship even in the great ports of the world where every quay is equipped with car tracks on both the water and the land side of the transit shed, except in case of heavy pieces or certain standardized package or bulk commodities.

Mr. R. A. C. Smith in his testimony in the Lighterage Case gave some pertinent figures concerning the impracticability of loading ships directly from cars. He took a case in point at one of the Chelsea Piers. There were two ships berthed at the pier, one a cargo liner of 16,000 tons (it was not stated that she had 16,000 cargo tons capacity) and the other a freighter with 8,000 tons cargo capacity. The larger ship spent the total of five days in port, which is rapid dispatch for such a ship at any harbor. However, it seems quite certain that the ship was a liner and did not discharge 16,000 tons of cargo and load an equivalent amount in five days.

Now, according to the Commissioner, if the ship of 16,000 tons capacity had been loaded from freight cars directly it would have required 480 cars, or a train 19,200 feet long, 3½ miles. If the cars could be marshalled in such manner that there would be no delay in drilling in two rows of eight cars, or 16 in all, it would take 30 shiftings to accommodate 480 cars. The best time that could be made in unloading one set of 16 cars would be four hours which he considered the utmost speed. It would take 120 hours to unload all the 480 cars. Working all the time, 24 hours of the day, it would take five days to load the ship. As the ship can not load until after it has discharged, it will be seen that allowing half of the time in port for discharging at the same speed as loading it would have taken 10 days to turn the ship around. Therefore the present system would be twice as fast as car-to-ship loading.

The figures seem convincing and they were very convincing to most people, and not the least to Mr. Smith himself. What he said is true enough. Yet when one stops to think that at other ports in the world, in particular Antwerp, Rotterdam and Hamburg or Bremerhaven, the practice of car-side delivery is continued at all the new basins after many years' experience, and when it is known that the speed of turning a ship around is at least as great as, usually greater than, at any American port, one sees that there must be something wrong in the reasoning

As a matter of fact the reasoning is based on a false premise, as is the entire controversy. It is based on the premise that freight is to be transferred *directly* from car to ship. In very few instances is this done. When very heavy pieces are to be loaded the cars are spotted, marshalled, and drilled alongside the ship on tracks situated at the quay edge. Such pieces arrive on gondola cars or on flat cars. Even so, in the case of loading locomotives, boilers, engines, and other similar pieces, the quay cranes of three to five tons can not do the work, and either the ship is moved to one of the 100 ton cranes, or, which is more usual, a derrick lighter floats the heavy pieces alongside from some siding. We may say, therefore, that for heavy pieces, which are not too heavy for the regular cargo cranes, and when delivered in open cars, loading does take place directly from car to ship's hold. Also for bulk freight which is tipped into the hold from the car by a car-hoist or "tipper," such as coal, ore, and sometimes grain, direct loading is possible. These commodities form a small percentage of general cargo and are the exception rather than the rule.

The function of the belt railroad with shipside spurs is not to load from car to ship as a rule. The movement is to save rehandling to lighters or draying from railroad terminal or warehouse to the transit shed.

The loading of belt-line railroad freight is as follows and not as described in the above testimony. The sheds are ample in area with decks not cut up by tracks or teamways. The tracks outside the sheds permit cars to be brought to both the front and back of the shed for unloading *into the shed.* This is done before the ship is ready to load. The function of the shed is to act as a temporary reservoir for the assembling of outgoing cargo so that the cargo may be quickly loaded when the ship arrives. The freight as it is unloaded from cars to the shed is placed according to kind of freight or ports of consignment. The freight is thus assembled at ship's side from cars which have come unbroken to near the ship's side.

In the meantime the ship has been discharging at another quay reserved for inbound freight. The inbound shed in like manner takes up the cargo as a reservoir pending further disposition. The further disposition is of secondary importance compared to the rapid discharging of the cargo. Once it is lightened the ship is warped across the basin to the loading quay where the freight, properly assembled, may be loaded at a speed limited only by the speed of stowing it in the hold.

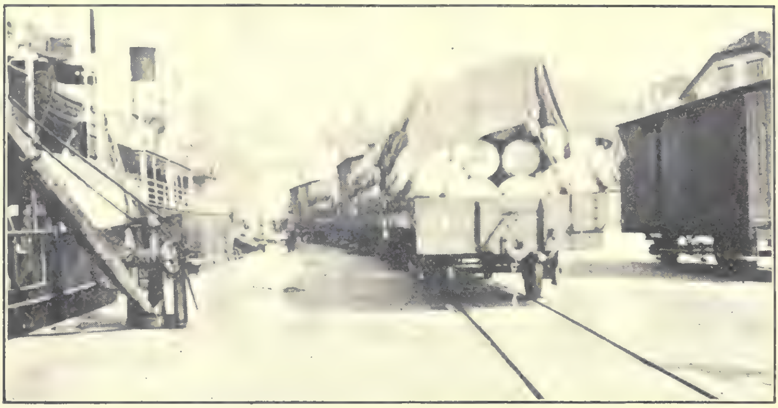
It must be added that the shipside car is only of interest when there is the inner belt line and when there is room for tracks on the quay and still room for the proper amount of deck space for working the cargo.

In addition to railroad freight there is a vast amount of freight taken overside, from barges, lighters, or heavy-duty derricks. Coal is loaded overside and also grain. Both sides of the ship must be worked.

Therefore, to sum up, the car seldom loads directly to the ship, but usually to the shed for transit storage and for working. The advantage of the car-to-shipside system is that there need be no handling of freight between the point of origin and the point of unloading at the pier shed. The economy is in this point of the movement and nowhere else.

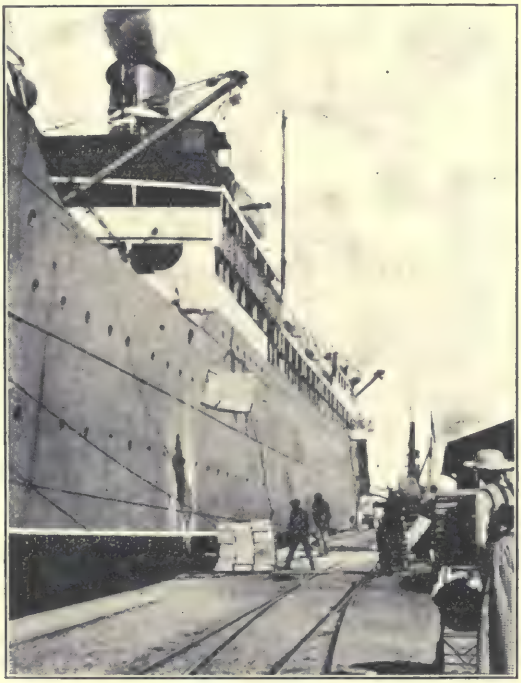
Location of Tracks.—Where there is no belt line the New York system of moving cargo across a narrow pier to lighters is the equivalent. When there is a belt line and car tracks are run onto the piers the question arises, where to put the tracks. If the tracks are run down the center, the piers at once must be twice as wide because the tracks divide the pier sheds into two separate narrow sheds in which the freight for the railroads is moved across the deck to waiting cars instead of to waiting lighters.

Recent American pier design has taken this fact into consideration. Notably at Philadelphia, where the railroad freight is 75% of the whole, the tracks have been laid down the middle of the pier and the pier made wide enough to leave two separate shed floors, one on either side. Although they are on one pier and under one roof, in fact there are two sheds as far as working cargo is concerned.



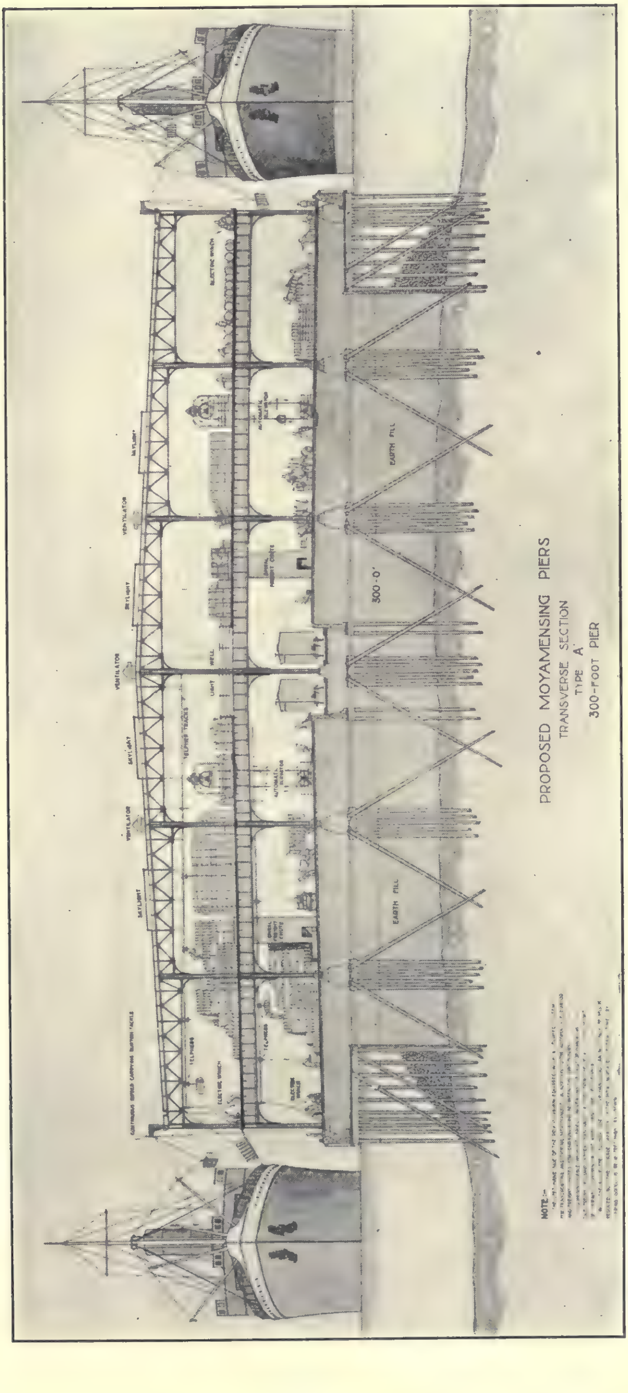
(Photo by author)

FIG. 38.—Quay at Stavanger, Norway. Loading from rail to ship's side.



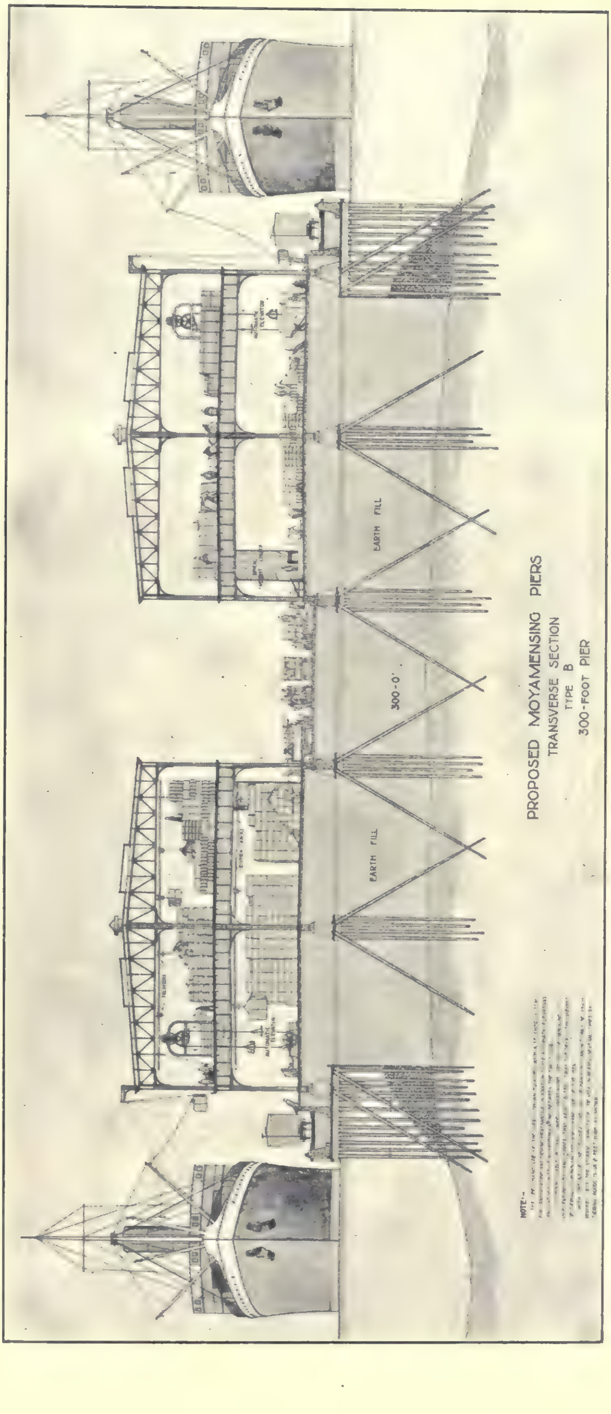
(Photo by author)

FIG. 39.—Quay at Stavanger. The Bergensfjord loading sardines with its own tackle. The quay has no mechanical loading equipment, but rail facilities enable goods to be brought to the ship's side and stacked near the ship's sling.



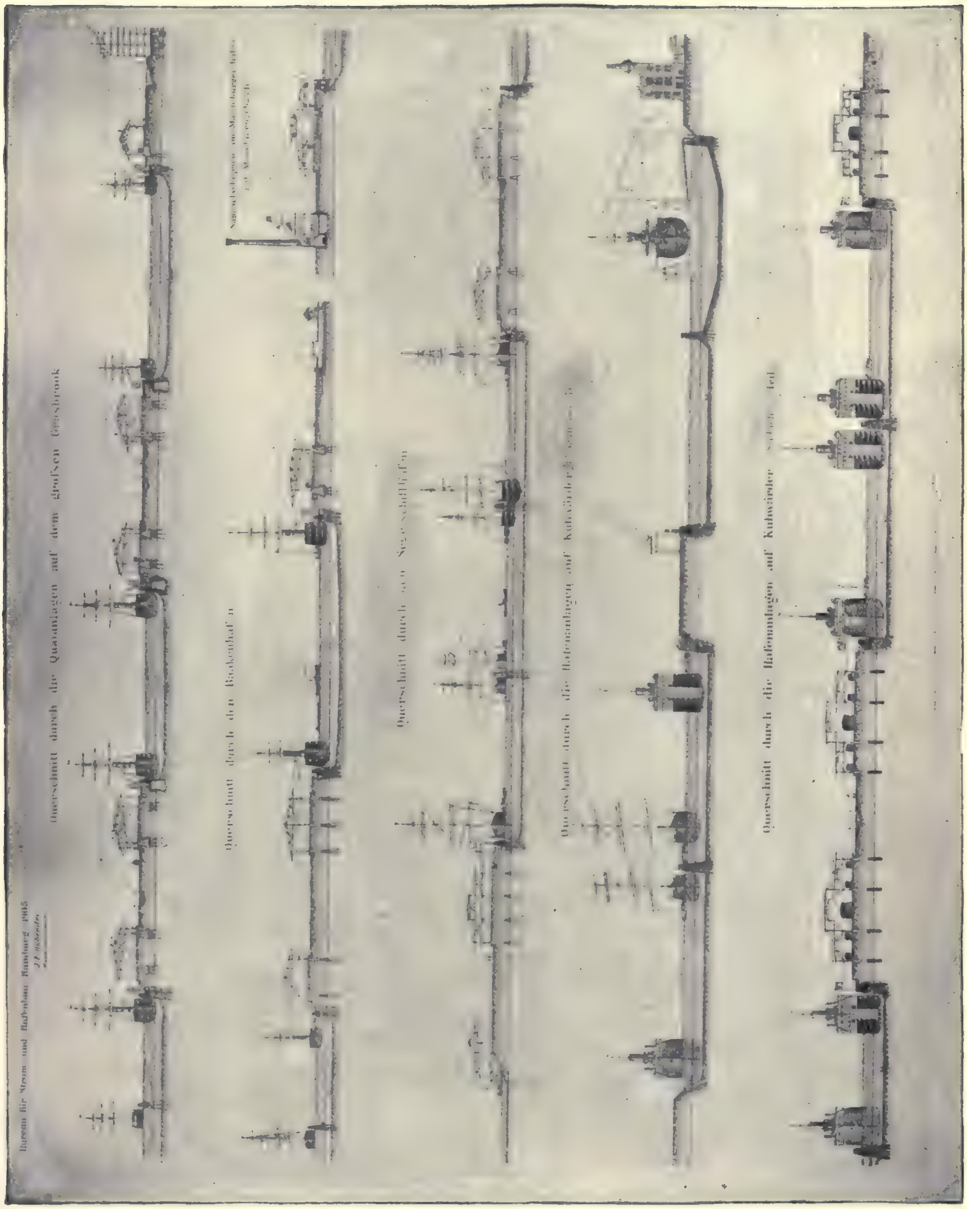
(Courtesy of Dept. of Wharves, Docks and Ferries, Phila., Pa.)

Fig. 40.—Proposed Moyamensing Piers. Type A.



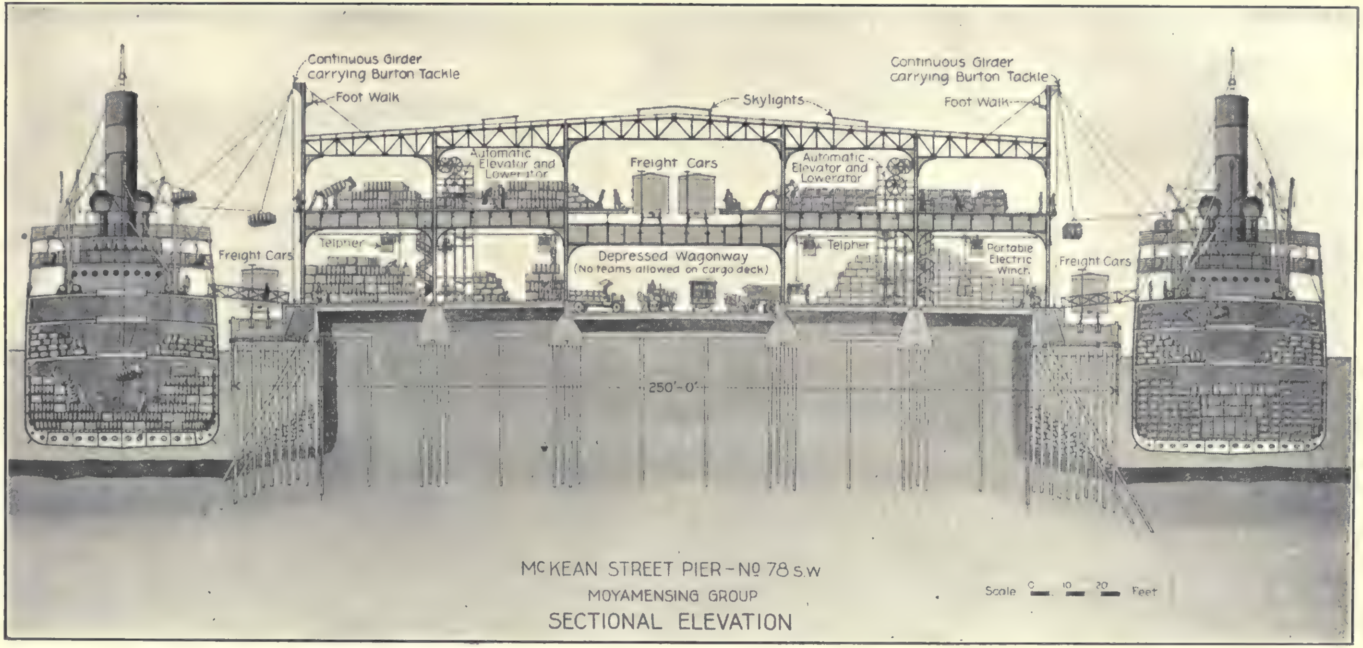
(Courtesy of Dept. of Wharves, Docks and Ferries, Phila., Pa.)

FIG. 41.—Proposed Moyamensing Piers. Type B. (not executed.)


Bureau für Strom- und Hafenbau Hamburg 1905
Querschnitt durch die Quaianlagen auf dem großen Grasbrook
Querschnitt durch den Baakenhafen
Querschnitt durch den Segelschiffhafen
Querschnitt durch die Hafenanlagen auf Kuhwärder
Querschnitt durch die Hafenanlagen auf Kuhwärder

(From Report of Conn. Rivers and Harbors Commission, 1910)

FIG. 42.—Cross-sections of typical Hamburg harbors.


Continuous Girder carrying Burton Tackle
Foot Walk
Skylights
Continuous Girder carrying Burton Tackle
Foot Walk
Automatic Elevator and Lowerator
Freight Cars
Automatic Elevator and Lowerator
Freight Cars
Telpher
Depressed Wagonway (No teams allowed on cargo deck)
Telpher
Portable Electric Winch
Freight Cars
250'-0"
McKEAN STREET PIER - No 78 S.W
MOYAMENSING GROUP
SECTIONAL ELEVATION
Scale 0 10 20 Feet

(Courtesy of Dept. of Wharves, Docks and Ferries, Phila., Pa.)

Fig. 43.—McKean Street Pier. No. 78 S. W.

In the drawings (Fig. 40) of the new Moyamensing Piers the cross section of Type A shows a total width of 300 feet with the car tracks down the center and two roomy transit-shed floors, one on each side of the track. This system has been used for some time in other smaller and older municipal piers. Fig. 41 shows Type B with a driveway for teams down the center and the car tracks moved to the outside edge of the pier. The movement would be by tackle hoists over the car tracks to the shed and then into the cars to be shipped by rail from the shed. The driveway for teams has completely divided the pier into two separate units. When the first of the Moyamensing group was built (Spring 1918), it was given the floor plan of Type B, but on investigation it was found as economical to roof over the entire pier including both pier sheds and carry the upper deck through, as to build the sides of the two sheds. This arrangement gave the teams covering while loading and at the same time added the space of the driveway to the second deck of the pier. Compare Hamburg cross sections Fig. 42. Fig. 43 shows the McKean Street pier, No. 78, Philadelphia, with its car tracks on the upper deck in the cnnter and on the lower deck with the tracks outside and with the teams in the

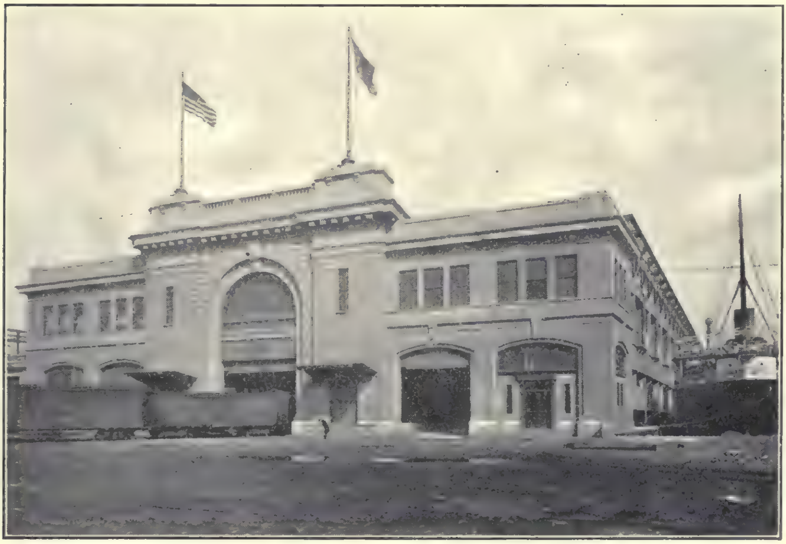


Fig. 44.—Pier No. 40 South Delaware Wharves.

middle. Fig. 44 shows the cars entering Pier 40. Fig. 45 shows the inside of Pier 40 with the car tracks down the center. At this time 3,680 tons of flour were held on the main deck pending loading. It was tiered rather high, but otherwise it could not have been accommodated.

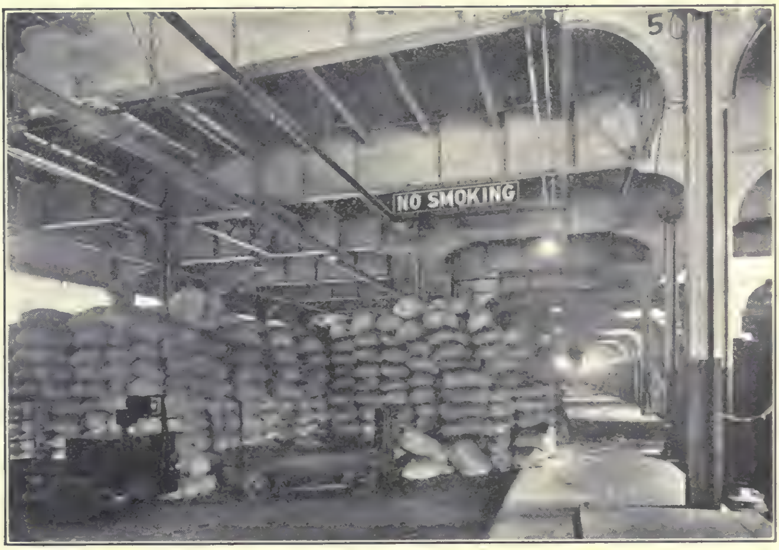


Fig. 45.—Pier No. 40 South Delaware Wharves. Cargo of 3,680 tons of flour on main deck.

Teams and Motor Trucks.—The other movement from the pier, after the lighter and the railroad, is by dray or motor truck. This movement, except in the case of railroad freight at Manhattan, is much the smallest of the movements of the cargo.

The congestion on the railroad piers at Manhattan is due to the fact that as it is the piers can not carry sheds of sufficient area to accommodate the freight, and in addition teams and drays are permitted on the piers to load parcels for the consignees. The wide pier as at Philadelphia, with ample deck room on each side of a roadway would be the solution. With such piers it would be possible to drive to the loading point and receive the parcels from a loading platform of wagonbed height. In this case the car-floats would not be of the platform, 12-car type, but of the 18-car type and therefore more economical. Freight would be unloaded directly to the pier. Congestion would be

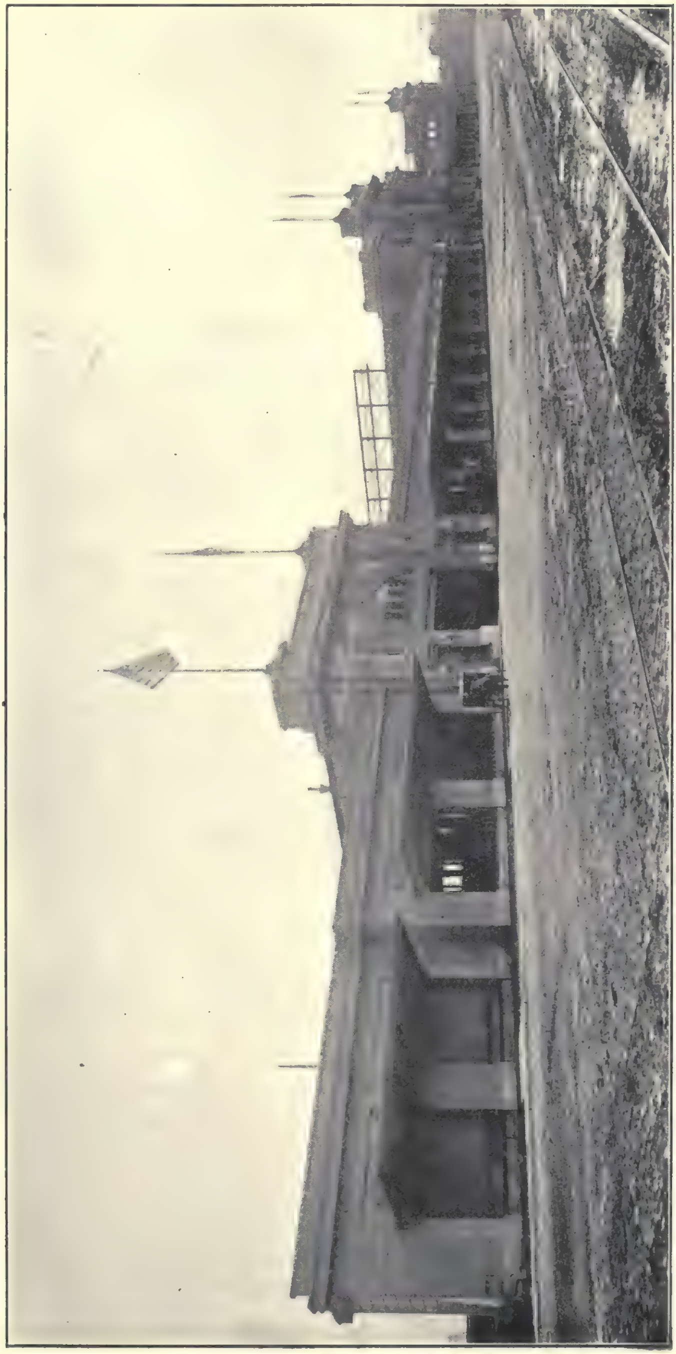


Fig. 46.—Pier No. 36 South Delaware Wharves. View looking south on Delaware Avenue.

eliminated because of the free movement of the teams down the center roadway to the point opposite the merchandise to be loaded.

This is not possible on narrow piers which have no provision for teaming space, or on piers whose principal movement is by rail. The solution is to move the freight, by mechanical means if possible, as described in the chapter on carting, to the bulkhead house. This is the building at the entrance to the pier and extending along the bulkhead. This loading platform at the bulkhead should be reached by telpher or electric truck. There should be a loading platform of dray height. This platform is shown at a Philadelphia bulkhead (Fig. 46) and also the electric trucks serving as the connection between the distant pier and the head-house (Fig. 47).

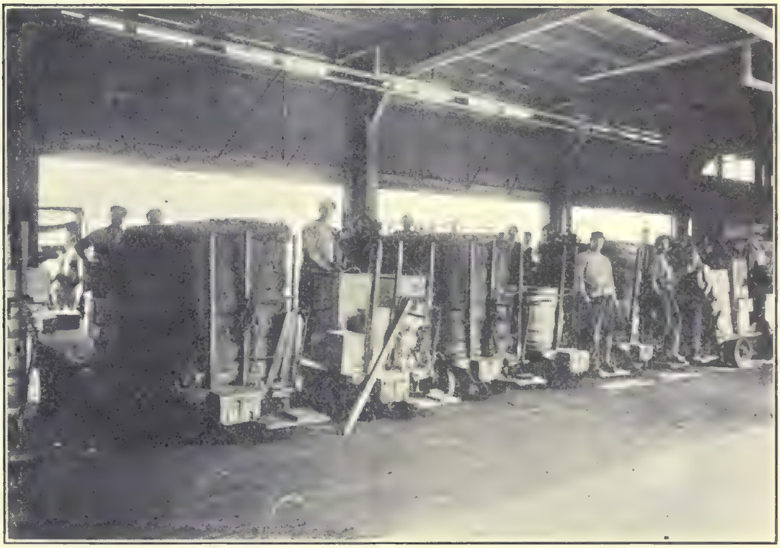


Fig. 47.

Mr. George S. Webster, Director of Wharves, Docks and Ferries, Philadelphia, at a meeting of the Engineers Club of Philadelphia, in a discussion on ports, made these remarks:

> "The piers as planned (in South Philadelphia, Moyamensing Group) are of ample width to accommodate all business that we believe will come to them. We find that those who handle trucks in the City of Philadelphia have very much less objection to going several miles to a

wide pier where there is no congestion and delay than going to a pier immediately on the waterfront where, because of congestion, they may wait for several hours or even an entire day to unload."

In the case of railroad freight at Manhattan this head-house delivery to drays would be a large job. However, elsewhere, on analyzing the percentage of drayage of *maritime* freight it is seen to be about 20% of the whole and this small portion should by all odds be taken to the head-house rather than have the teams come onto the pier.

At the Bush Terminals the movement of freight is analyzed as follows:[1]

30 per cent. is destined for the warehouse (by means of elevator truck or mule "lorry."

25 per cent. C. L. railroad freight (usually car floated).

25 per cent. L. C. L. railroad freight (usually lightered or car floated).

20 per cent. dray for local delivery.

At Hamburg the half of the freight which does not go overside in stream for barge transportation on the interior waterways, but over the quays, has the following distributions.[2]

18 per cent. by rail (C. L. and L. C. L.).

20 per cent. dray to local consignee (or L. C. L. to railroad).

45 per cent. by lighter to warehouses or to river express barges.

17 per cent. goes into barges over the quay after the ship has left or over the water side of the ship at the quay.

The Two-Decked Pier.—Contrary to the usual custom in European ports there has been a strong tendency towards the two-decked type of pier shed construction in America in recent years. There has been the need of more space, the need of keeping incoming and outgoing freight separated without moving the ship, and also the need of economy in waterfront along the congested portions of the cities. As American wharves are not built along artificial basins which can be made to order with the proper amount of upland, the double deck has been the compromise.

Incoming and outgoing cargoes are given separate decks. However, unless there is absolutely the same connection by team and railroad to each deck from the level of that deck, there must be connection between the two decks. This connection serves to lower the degree of segregation of in- and outbound freight. It also involves much elevating and lowering from one deck to the other. These movements are accomplished by goods lifts, or ordinary freight elevators, by spiral chutes and by continuous motion parcel elevators. All of these are used on the Philadelphia piers and elsewhere. There is no doubt that this between-decks movement is costly in time and labor. To build outgoing and incoming freight sheds of one story in such relation to each other that the movement of the ship is only a shed length along the pier or quay or a matter of warping across a narrow basin or slip should be encouraged wherever possible.

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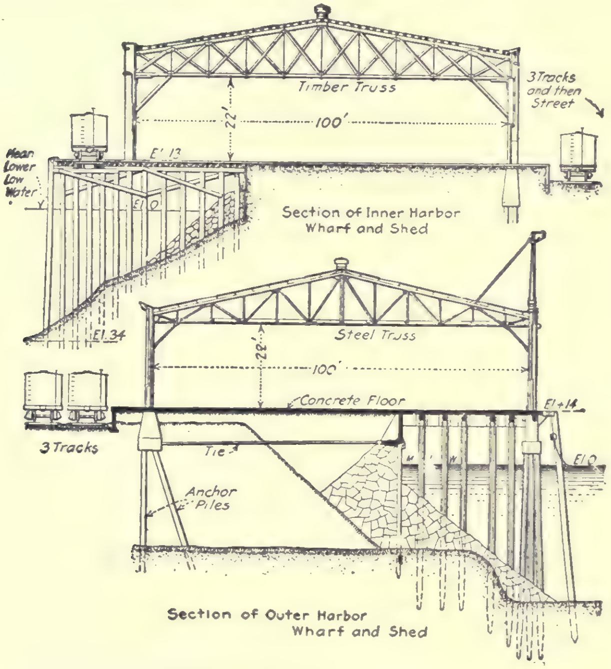
[1] Testimony I. C. C. Lighterage Case.

[2] Clapp, "Port of Hamburg."



(From Green "Wharves and Piers.")

FIG. 48.—Cross-section of a wharf and wharf-shed showing location of car-tracks.

Length of Piers.—The discussion of the width of piers also involves the question of length. The length of piers depends on the War Department in the United States. At New York and elsewhere 1,000 feet is about the limit allowed, although in South Brooklyn there are piers of 1,700 feet. There are, however, certain considerations of an administrative nature which effect the economy of length. *The longer the pier the wider it must be.* The reason for this is that the longer the pier is, the more traffic must be handled at the bulkhead end. Its length increases the number of cars and battery trucks which go onto the pier, and if teaming is allowed the longer the pier the more cargo there is and the more teams will be needed.

On the other hand the *wider the pier the longer it must be.* The more waterfront the pier occupies the longer it must be in order to attain the maximum berthing space. There are several things to be considered here.

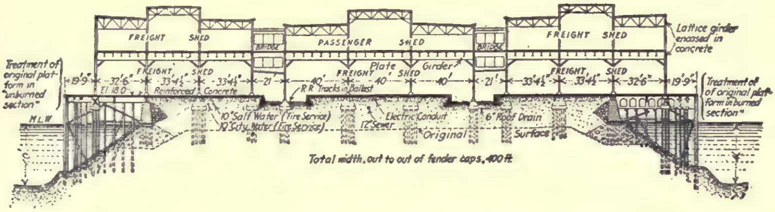


FIG. 49.—Commonwealth Pier, Boston, Mass.

When a pier becomes longer than 1,000 feet it is uneconomical to move freight by hand or electric truck to the bulkhead for loading into railway cars or drays. When either teams or freight cars are admitted to the pier the space for sorting and handling is greatly reduced. Unless the pier is widened congestion grows rapidly with the length of the pier.

When a pier is longer than 1,000 feet the pier slip must be wide enough to pass large ships beyond a ship berthed near the channel end, but not occupying all the berthing space. The pier and its slips must be of a much greater width as soon as the one ship per slip limit in length has been reached. With accommodation for ships of about 11,000 tons gross, quays or piers would be 500 feet, 1,000 feet, 1,500 feet, 2,000 feet, or some other multiple of 500.

It therefore becomes necessary to depart entirely from the Chelsea type of narrow pier construction and go to another design. The enlargement of the Moyamensing design would give two rows of sheds with teaming and railroads between. Such a pier would be uneconomical of waterfront unless made very long. Once it is made wide it may be made several thousand feet long.

This is only possible where the water is wide and shallow to permit pile-fill structures with dredged deep water between, or a low and soft shore to permit excavation of the slip into the land. At N. Y. the limit on the Manhattan shore seems to have been reached with 1,000 and 1,200 feet piers. At Bayonne or Stapelton Cove, S. L., or at Jamaica Bay piers of a mile in length with a width of 400 feet and slips of the same width or more are not only possible but urgently desirable. If a pier or quay is more than a mile in length and used for passenger service there should be street car connection with the town. The long European basins are made accessible to people having business in various parts of the harbor by small steamboats.

PIERS

Name and location of pier	Length (feet)	Width (feet)	Width of slip (feet)	Type piles filled	No. of railroad tracks	Profit
Pier 36, Clyde S. S. Co...	1,003	75	......	Piles		
Pier 59................	825	125	......	Piles		
Bush Pier 6............	1,241	270		Piles		2 tory
Bush Pier 4............	1,335	150				
San Francisco, cost $3.50 p. sq. ft. of deck	222 555 720 807	Pier 200 Shed 156	......	Piles	1 track	
Chicago Municipal Pier..	3,000	292 Sheds 100	......	Solid fill	Street R. R. 4x	2 story
South Brooklyn........	1,745	175 Shed 140	......	....	2 track outside	
56th Street, New York..	1,000 Shed 921	....	......	Piles	2 above 2 below sunken	Load 500 lb. 300 lb. 50 lb.
Havana, Cuba (2).......	680	164	262½	Concrete piles	2 tracks 2d floor	2 floors, concrete
Philadelphia............	550	180	200	Piles and fill	2 center Main deck	Load 600 lb. 2 decks
Touchwark...........	Ca. 600	250	250		Main deck	2 decks
South (4)............	Ca. 7,000	300	300			2 decks
Commonwealth.........	1,000	400	......	Piles, solid fill	6 tracks	3 sheds 20 ft. margin
Halifax (4)............	693	Pier 235 Shed 200	......	....	2 middle 1 each edge	Loads 1,000 500 100

CHAPTER X

CARGO TRANSFER AND HANDLING

In handling the cargo of a ship two things are to be desired, speed and economy. Speed is economy because a ship in port is a liability and is only an asset when at sea. Sometimes the cost of handling the cargo is offset by the increase in the speed. Sometimes reductions in the cost of handling are only illusory because the reduction of handling expenses is accomplished with a lengthening of the time of the ship in port. Usually it is possible to reduce handling expenses and speed up the turning around of the ship by the same methods. However, in the study of the situation the time element as well as economy of operation must be kept in the foreground.

There are two distinct movements involved, "transference" of cargo from ship to wharf and "handling" of the cargo on the wharf. Transference is of two kinds, from side ports as is the case in all Lake and coastwise or river boats, and from the hatch in the case of ocean vessels. The first is a lateral movement and the second a vertical movement, or the first is a low trajectory and the second a high trajectory. Handling the merchandise on the wharf consists of three general operations, sorting, tiering, and delivery to various land and inland water carriers.

Side Port Discharge.—This movement is generally accomplished by stevedores with hand trucks passing back and forth between the vessel and shore along a gang plank. Some data on the time and costs of side port stevedoring are given by Mr. Harding, for New Orleans. A steamship company with a total waterfront berthage of 2,100 feet and a wharf area of 209,680 square feet in 1912 transferred 581,172 short tons of general cargo at an average rate of 125 tons an hour, and an average cost of 54.85 cents a ton. The wages paid were 30 cents an hour with 40 cents for Sundays and overtime. Of course this could not be done for the same wages in 1918.

Here is an example dated January 25, 1913. In 11½ working hours 355 men discharged, distributed, and tiered 1,725 tons of general cargo, which is a speed of 150 tons the hour. Also 2,831 tons of general cargo were loaded in 21½ hours by 200 men, which was a speed of 131 tons the hour. Five gang planks were used. It cost 74 cents a ton. Over this particular wharf the average tonnage transferred per linear foot was 267¾ for the year.[1] A recent report of the Inland Navigation Company operating a modern self-propelled barge on the Mississippi River showed that transfer costs range from 50 cents to $1.50 the ton.

Side Ports and Water Level.—The variation in the water level due to tides or river conditions will greatly affect the grade of the gang plank and the efforts demanded of the men to move the goods up the incline. At Boston and elsewhere the tide variations have been hard to meet. To accommodate the coastwise trade with side ports, the wharves have been built with adjustable ramps, and mechanical aids to the stevedores have been installed. The best known is the Reno Conveyor (Fig. 50) of the Otis Elevator Company. A letter from the company gives the following data concerning their product:

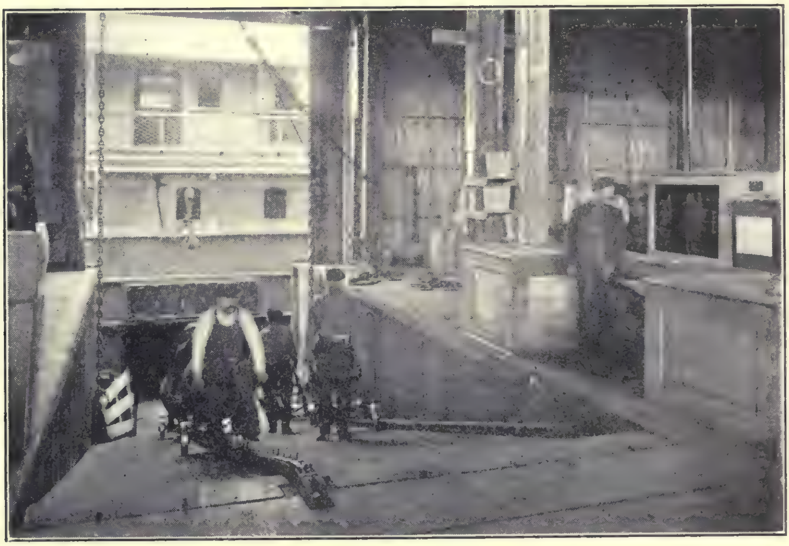


FIG. 50.—Side port discharging at low tide facilitated by a moving chain with lugs to engage the handtrucks and haul it up the ramp.

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[1] HARDING, *International Marine Engineering*, March, 1913. Also *Federal Government Reports*, 1913.

"The Otis Inclined Elevator is a continuous carrier of package freight on an incline. It consists of an endless chain provided with lugs which engage the axle of the truck, this chain running on sprockets which are driven by a low-speed electric motor and reduction gearing.

"In regard to the savings affected by this piece of apparatus, the Metropolitan Steamship Company, whose docks are equipped with these machines, advises us that there is a 25% saving in time of discharging steamers by the use of inclined elevators. The cost of loading and unloading is reduced from 45 cents per ton to 28 cents or 30 cents per ton.

"The Merchant and Miners Company of Baltimore reports a saving of 13% to 15% in the handling cost. They use our inclined elevators for hoisting motor trucks with a 1,500 to 2,500 pound load up a 35% grade. They claim also that they have handled boiler plates weighing as much as 4,200 pounds on hand trucks by the use of these machines.

"The New York Central Railroad Company has a number of inclined elevators installed in their Weehawken, N. J., piers and they report an increased capacity in their marine equipment of from 20% to 40% depending on conditions. This company also claims a labor cost reduction of two cents to three cents per ton on freight handled.

"The Old Dominion Steamship Company, whose piers at New York and Norfolk are equipped with these machines, claims a saving for each machine of the labor of four men at a labor cost of 30 cents per hour for a working day of five hours.

"These statistics were furnished us in 1915, but are the latest we have on hand and it is possible that, owing to changed conditions due to the war, they may not be correct for the present time."[1]

Portable Conveyors.—Another machine which has been put on the market and is gaining in popularity for side port transfer of cargo is the portable conveyor. A section operated by its own electric motor driven by a plug and cable connection with the main power line, is pushed from the wharf into the vessel. The conveyor is simply a moving gang plank. It has the advantage over the Reno type that the stevedores do not need to pass to and fro between ship and wharf, but may work at each end of the animated gang plank. On the other hand, the machine is more expensive. The municipal wharves of New Orleans are equipped with several of these conveyors.

Hatch Transfer.—Ocean vessels load and unload through deck hatches. There are three kinds of unloading:

I. By means of the ship's tackle where there is no wharf equipment.

II. By means of the cargo mast where the ship's tackle and a wharf winch are used together.

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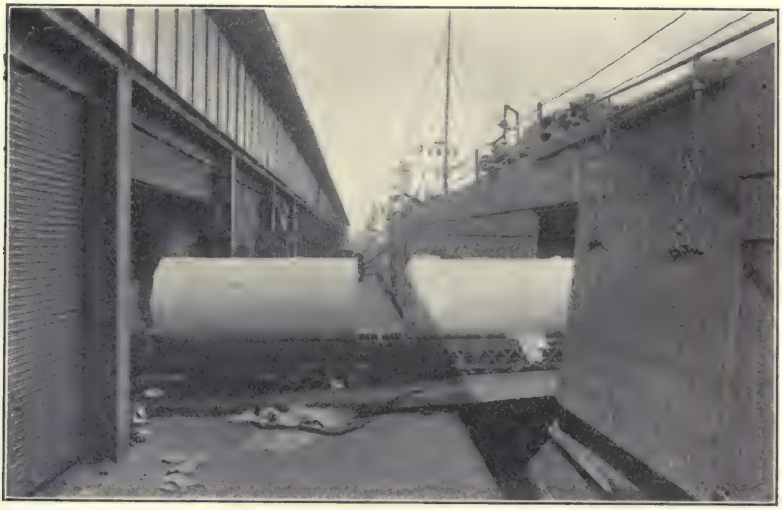
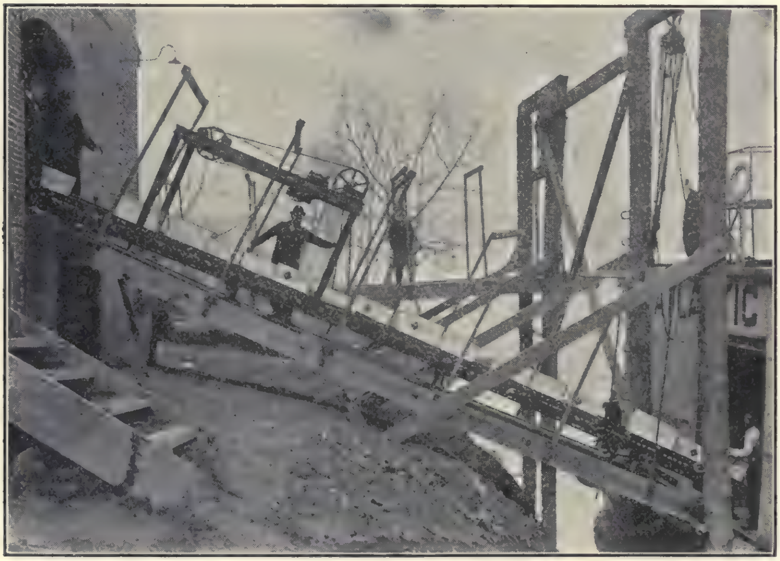
[1] Letter to the author from the Otis Elevator Company, N. Y., November 5, 1917.

III. By means of cranes on the wharf which do all of the work. The economy of one over the other depends entirely upon the



(Brown Portable Conveyor Co.)

FIG. 51.—Side-port transfer by means of portable conveyor.



(Brown Portable Conveyor Co.)

FIG. 52.—Side-port transfer by means of portable conveyor.

amount of cargo transferred between ship and wharf during the year. Each succeeding method involves greater capital investment in wharf equipment. Unless the volume of freight handled is increased, the interest and amortization of the increased investment will not be met by the saving accomplished.

I. Ship's Tackle.—All steamers other than tankers carry their own unloading machinery. Between the two forward hatches is a short stout mass with several movable booms and another between the after hatches. The modern freighter has as many as ten booms to a mast. Together with donkey engine and tackle, loads of a ton or more may be handled by each boom and engine. The cost of transferring freight by this tackle is not large, not over six cents to seven cents a ton on the average. This includes placing the cargo in the sling, lifting it out of the hold, and depositing it on the wharf or lighter.

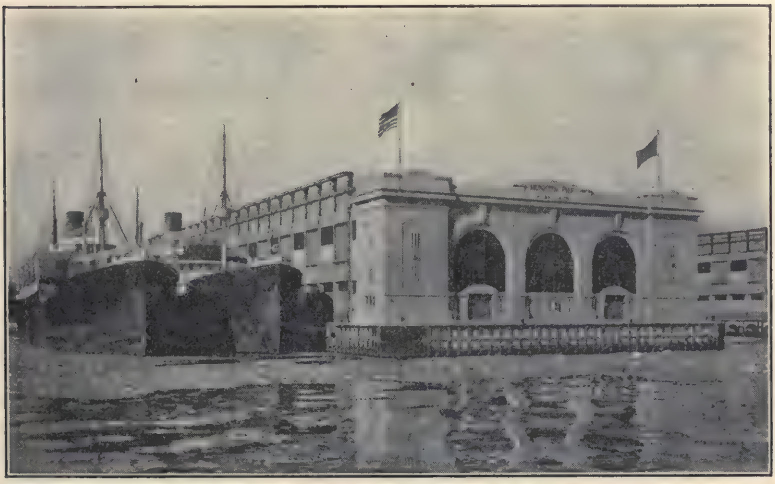


FIG. 53.—Two decked municipal piers at Philadelphia showing cargo masts. The pleasing architectural treatment is a worthy example that the waterfront of a commercial port may be orderly and artistic as well as efficient.

II. Cargo Mast.—The American machineless unloading may be defective, but there is no room on a narrow pier for cranes. The cargo mast is a successful compromise. On the pier edge, masts carrying a girder at a height of 75 feet to 80 feet above low water extend along the water's edge. A block and tackle with a line from a drum hoist on the pier to the hook is burtoned to this girder. A ship's boom and hoist also operate another line to the same hook, thus both ship's tackle and pier tackle work together. There are three movements. The load in the hold is attached to the hook, (1) the ship's winch raises the load, (2) the pier winch then starts to pull and the ship's hoist lets go, (3) the pier hoist then lowers the load. The movement made is without lost motion and by the shortest possible route. The cost of the installation is low, the saving in time is great. The cost of operating two hoists and two operators instead of one is greater than with the crane. The cargo mast operates at about 40 cycles an hour. This is the "first aid" where there is no room for cranes.

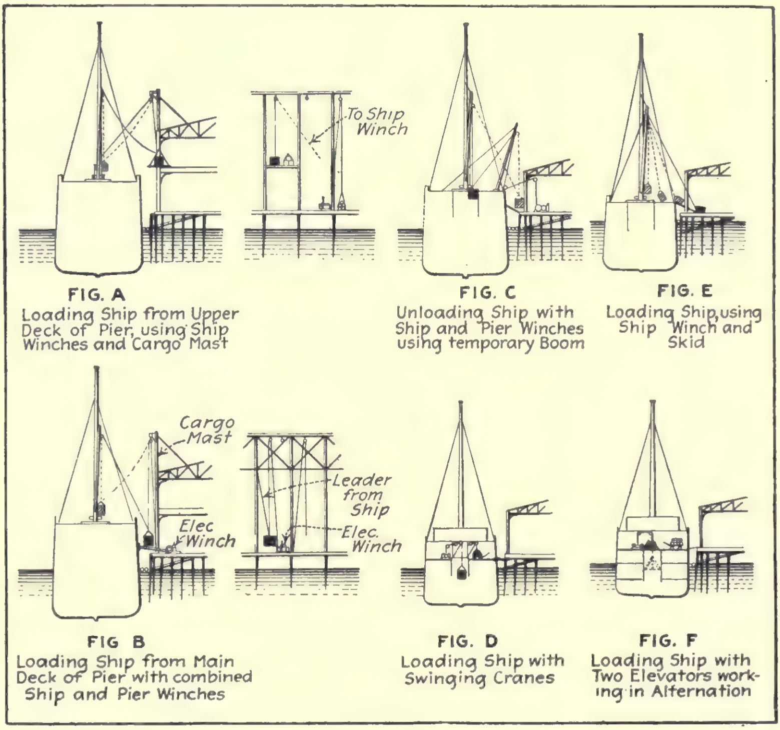


FIG. A
Loading Ship from Upper Deck of Pier, using Ship Winches and Cargo Mast

FIG. C
Unloading Ship with Ship and Pier Winches using temporary Boom

FIG. E
Loading Ship, using Ship Winch and Skid

FIG B
Loading Ship from Main Deck of Pier with combined Ship and Pier Winches

FIG. D
Loading Ship with Swinging Cranes

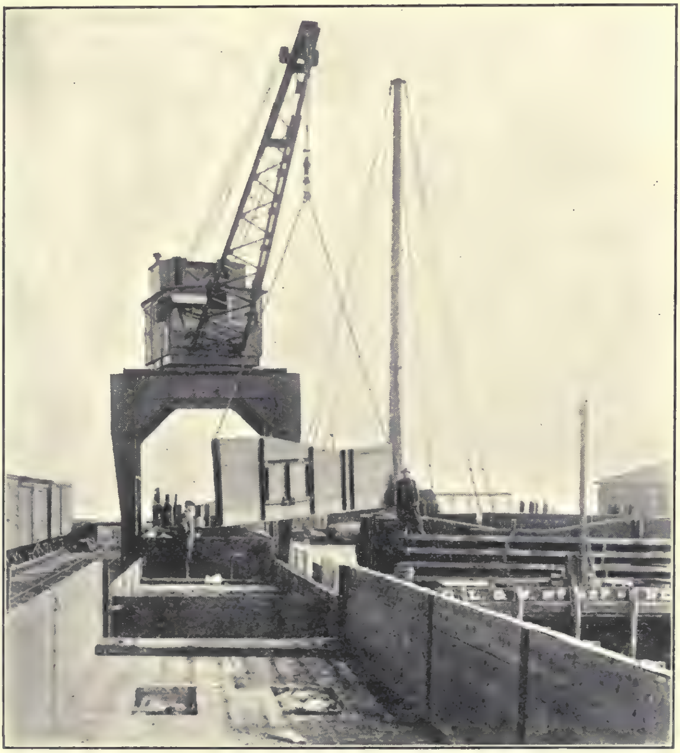
FIG. F
Loading Ship with Two Elevators working in Alternation

(B. F. Cresson, Jr.)

Fig. 54.—Methods of loading at New York.

III. Cranes.—Wherever the volume of freight and available space warrant it, gantry cranes are the most economical and efficient transfer machinery. It is often argued that the reason why European ports use cranes is because the freight cars are open and the Americans do not use cranes because of the prevalence of the box car with us. This is like saying that it is warm in summer because there is no snow. The fact that the cranes are used extensively is the reason for the prevalence of the open freight car (Fig. 55).

One reason for the use of the crane is the fact that the large proportion of water transportation by barges makes unloading machinery on shore necessary. The barges carry only a mast, which is unstepped in port, and a hand-operated hoisting drum.



(McMyler.)

FIG. 55.—A heavy duty (20 ton) full arch portal crane spanning railway tracks. Used to transfer heavy pieces of freight from flat or gondola car to lighter or ship

Another potent reason is the fact that the equipment is supplied by municipal port authorities not looking to a large return on the invested capital. Still another reason is the fact that more cargo passes over a municipal public quay per linear foot and therefore the burden of the additional cost of the quay equipment due to the cranes is more diluted per ton lifted. A final reason is that the quay has more room back from the water's edge than the pier.

Piers of the usual New York type, by their very nature, are not capable of either accommodating cranes or furnishing them with sufficient tonnage to make them economical. The difference in the tonnage transferred per linear foot of improved quay here and abroad is due partly to the nature of pier traffic, which allows a longer idleness of berthing space at piers than at public quays.

"As an example for the port of New York it happened that portions of the waterfront of certain foreign cities had not been improved while other portions were, so that, as the whole port was fully occupied by vessels, it was possible to compare the unequipped sections with the equipped under favorable conditions to determine their relative utilities. The following figures are from the tabulated results comparing the average of these whole ports with those portions later equipped with machinery. It is easily deduced from these figures what is possible at the port of New York.

"These comparisons between the average transferring capacity per linear yard per annum at such ports are of instructive interest:

	Average of the whole port per linear yard	Average of portion equipped
Havre, France	385 tons	1,430 tons
Rouen, France	483 tons	1,121 tons
Marseilles, France	665 tons	1,694 tons

"Not only can the above figures be attained at the port of New York, but, instead of 150 tons per linear foot, much better results, on account of improvements made in appliances since the above figures were tabulated."[1]

The usual type of crane abroad is the semi-portal gantry jib crane 2½ to 5 tons (metric) capacity. The outer leg rests on a rail at the edge of the quay. The inner end rests on a rail outside the transit shed above the doors of the same (Fig. 56).

Some figures concerning the efficiency of the crane are given by Mr. Harding.

"The following figures are of official tests of 20 traveling jib cranes at Montevideo, South America, and from the result of these tests 13 more cranes were ordered.

"The crane manufacturers state in writing that they are willing to guarantee equivalent results by any of their harbor cranes.

"These figures, based upon the official acceptance tests of the port authorities, give data as to actual time of transference and the actual output per hour; capacity of the cranes, 5,000 kilograms, or 11,025 pounds; lifting speed per minute, 24 meters, or 79 feet per minute; revolving 1½ times per minute equal to 130 feet at the hook.

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[1] H. McL. Harding, *Journal of Commerce*, June 30, 1917. See also other articles in *International Marine Engineering*, "*Freight Handling*," etc.

"The current consumption is figured for a cycle consisting of the following movements; lifting 11,025 pounds out of the vessel 25.5 feet high, revolving the crane through 120 degrees, lowering the load to the wharf, lifting the empty hook, revolving the crane through 120 degrees back to its original position and lowering the hook to the position from which it was started. This was repeated a number of times in order to get the average time per cycle.

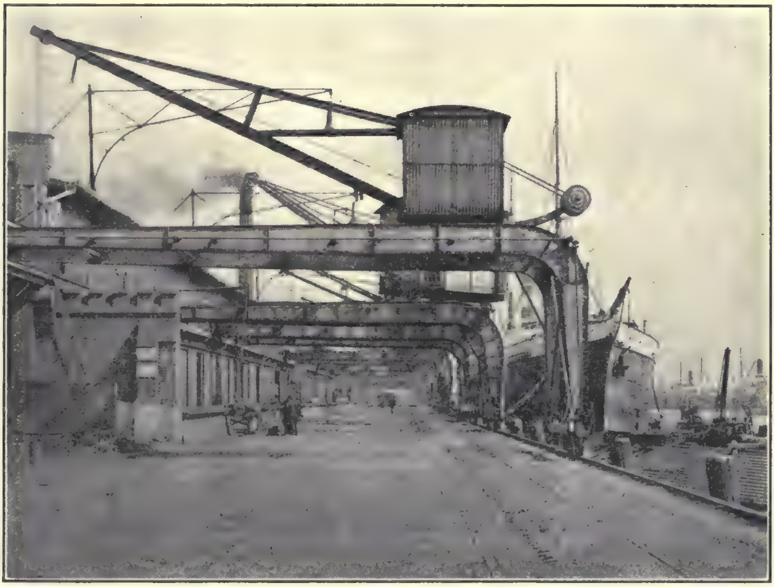

FIG. 56.—Semi-portal gantry crane, with car tracks set flush.

"The time for one cycle was 70 seconds, to which 20 seconds have been added for attaching and detaching the load, therefore the crane made 40 cycles per hour, making an output of

$$5 \times 540 \times \frac{2205}{2000} = 220 \text{ tons of } 2{,}000 \text{ lbs.}$$

"From the above figures, made under the favorable conditions of a test, it will be seen that 220 tons are possible per crane, and with a vessel with five overall hatches it is possible to operate two cranes at each hatch, which means that ten cranes can be working at one time; which would give 2,200 tons of 2,000 pounds per hour.

"There are similar records from most European ports extending over months and years of practical operation.

"Making all due allowances, raising only one consignment, mark or cross mark per draft of merchandise with two-ton or three-ton cranes, burtoning to overhead electric traveling hoists and adjustable loop cranes, the capacity per crane in daily service may be reduced to only 60 to 80 tons per hour per crane instead of 220 tons. This is extremely conservative and may be regarded as a minimum.

"With the ten cranes 600 to 800 tons per hour can be easily attained, including the loading when full load capacity can be transferred.

"In ten hours this would give 6,000 tons, and the vessel would be discharged and loaded in two days; 9,000 tons have been unloaded in a similar time, but the above can be made the average.

"That is, by such machinery as is installed in every foreign commerce port of England, Germany, France, or Holland, 6,000 tons transference per day are to be compared with the 1,500 tons at New Orleans. The ships' detentions will be one-third or one-fourth the time, and for the same berthing linear frontage four times as many ships can be berthed in a given period. The rental cost per ton would be one-fourth, and on a tonnage basis all the overhead charges would be also one-fourth."

The above figures refer to miscellaneous cargoes and not to ore and coal, which figures are greatly exceeded. The United States excels in ore and coal transference.

The cost of discharging and loading the vessel called *transference,* that is, the crane movements, will be guaranteed by the manufactures to be between three cents and six cents and the cost of handling, which may include assorting as well as distributing and tiering, will add to this and make the total cost between 13 cents and 18 cents per ton. These latter prices include all operating expenses, labor, electric current, interest, maintenance and amortization.

We have, therefore, a maximum of 18 cents per ton of 2,000 pounds of machinery against the present minimum of 54.85 cents.

To the figures given above by Mr. Harding, may be added some rather more conservative performances of equipped quays.

Four to six of these cranes work a ship, sometimes eight. Two can usually work at each hatch. The usual rate of discharge at Hamburg is 250 tons of general cargo per hour.[1] The record of the "Saxonia" at Boston a few years ago was 190 tons an hour.[2] The Liverpool Handbook cites the case of "The

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[1-2] CLAPP, "Port of Hamburg."

Lake Champlain" which discharges 12,000 tons of measurement cargo in 48 hours, which is an average of 250 tons per hour. The record at New Orleans, it must be remembered, was for *side port delivery.* It was 130 tons an hour. It cost, however, 75 cents a ton, which is 20 times the charge for the use of the cranes at Hamburg.

The Number of Cranes Required.—The number of cranes required depends on the amount of freight which will pass over the quay paying crane dues to support the cranes. At Hamburg, in the new basins, the cranes are spaced every 100 feet. Of course, if the city borrows money at a low rate of interest on the bonds and builds an equipment which has to support only the interest on the bonds and amortization, it can afford to be generous. Here is a great difference between the municipal and the private terminal.

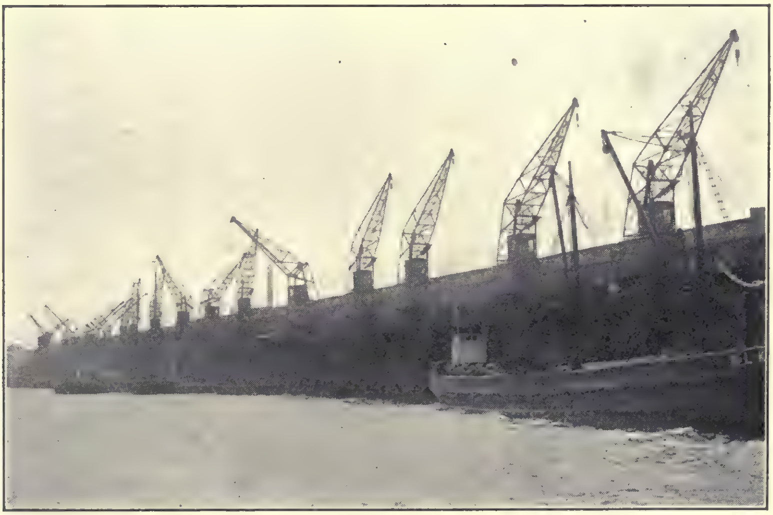
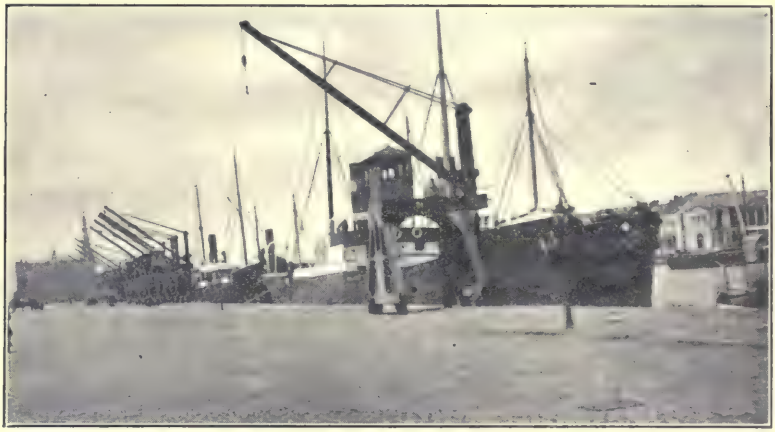


Fig. 57.—A Hamburg quay with a 3-ton locomotive crane every 100 feet.

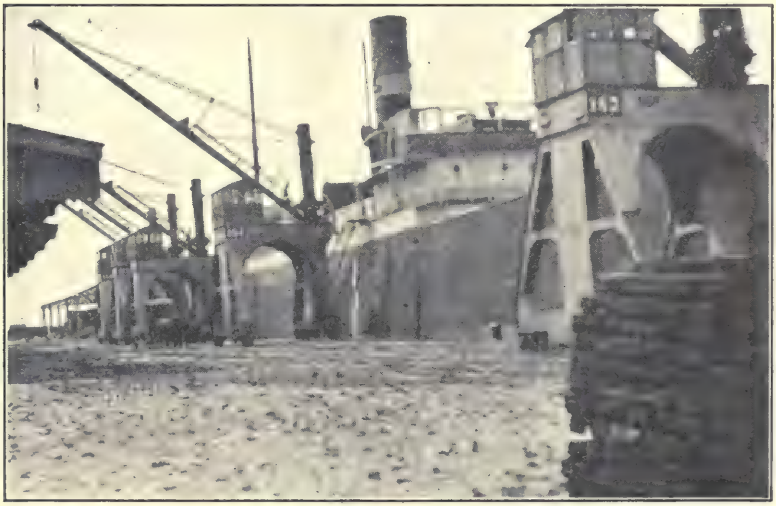
The new Galveston Cotton Wharf is content with two cranes for the wharf as a start, which is one crane for every 600 feet.

Relation of Cranes to Sheds.—To accommodate cranes it is necessary to set the transit shed back some distance from the water's edge. This immediately gives a greater area of deposit for the freight as it comes from the hold. Herein is one of the great advantages of the crane. One of the most vexing points of congestion is the point of deposit on the wharf. The area on the usual narrow pier, completely covered by shed, where the cargo from each hatch is to be set down is not over 8 × 8 feet, or 64 square feet. To work the cargo at full speed the stevedores must remove each slingload from this point of deposit immediately, as every minute and a half a new sling full



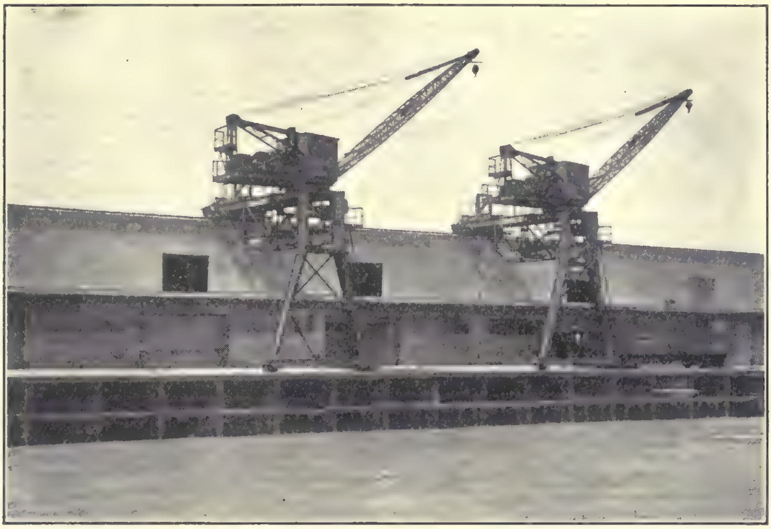
(Photo by author)

FIG. 58.—Antwerp. Portal cranes along the open quay of the Basin Bonaparte.



(Photo by author)

FIG. 59.—Antwerp equipment with sheds and portal or full arch gantry cranes.



(Courtesy Brown Hoisting Machinery Co.)

FIG. 60.—A 3000-lb. capacity electric gantry wharf crane, Galveston Wharf Co., Galveston, Texas.

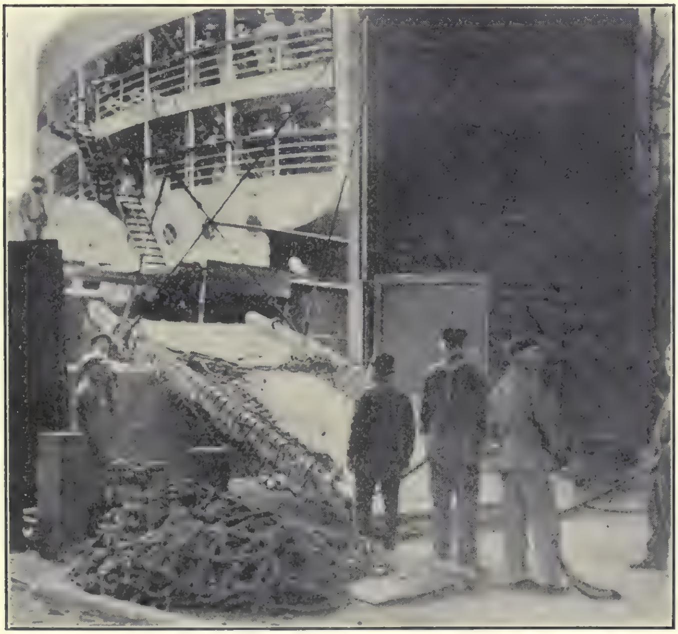


FIG. 61.—Unloading by means of ship's tackle onto a small point of deposit. The cramped area causes continuous congestion at this point.

arrives (Fig. 61). Above all else cargo must not "hang," waiting for room to be deposited. A wharf with the shed set back 30 to 40 feet and served by two jib cranes for each hatch will have a deposit space of 5,000 square feet or more. The larger area acts as a reservoir to take up the slack in the movements and avoid congestion opposite the hatch.

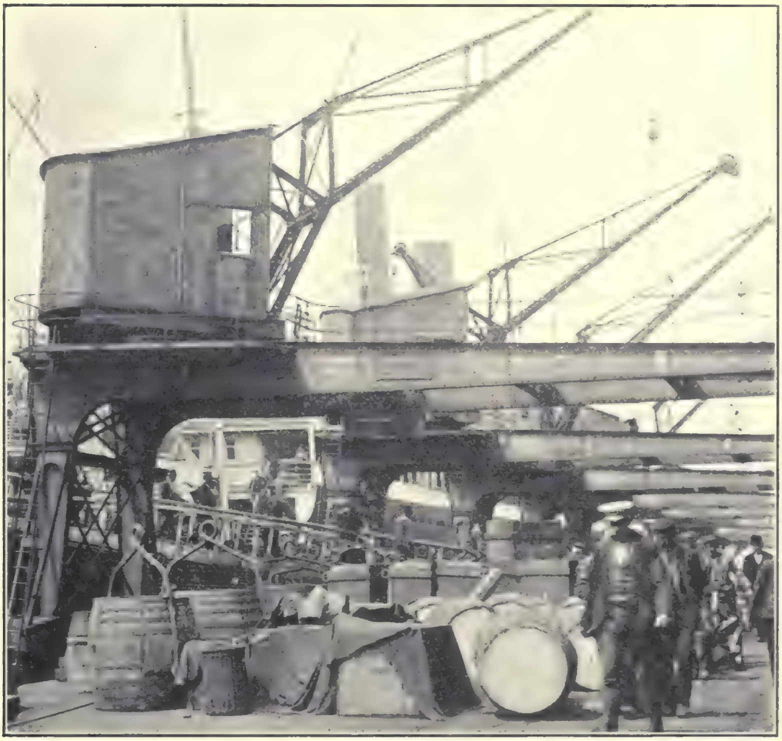


Fig. 62.—At Hamburg, when freight is brought out of the hold faster than it can be carted away, the cranes set it down anywhere, even on the railroad tracks.

At Antwerp, on some of the older quays, there are no sheds at all. In the newer basins the sheds are set well back, but the floor is the same level as the quay (see Figs. 58 and 59). According to the usual practice at Christiania, Copenhagen, Hamburg, Bremen, Havre, and many other places, the floor of the transit shed is elevated to the floor level of the railroad cars. In front of the shed is an open uncovered extension of the shed floor 6 feet to 12 feet wide. This serves as a point of deposit from which the stevedores take the freight into the shed. However, by rapid unloading this space may be filled. The cranes then deposit their loads anywhere in the intervening space (Fig. 62, Hamburg).

Railroad Tracks Again.—At European ports, gantry cranes, spanning the space of 30 to 40 feet from the water's edge to the shed floor, span two or three sets of railroad tracks between the shed and the water. These tracks are in addition to the tracks at the back of the shed. The position of these tracks has given rise to the supposition that cargo is usually loaded directly between car and ship. This was shown above not to be the case. However, some freight is loaded this way. Wherever the commodity is in large and heavy or bulky packages such as machinery, structural steel, logs, automobiles, etc., the loading does take place from car to ship. All such commodities both here and abroad are moved on flat cars or gondola cars from the point of origin to within reach of the crane for loading. As it is uneconomical to have wharf cranes of greater capacity than five tons, and usually they are about three tons' capacity, very heavy pieces are loaded and unloaded by derrick lighters.

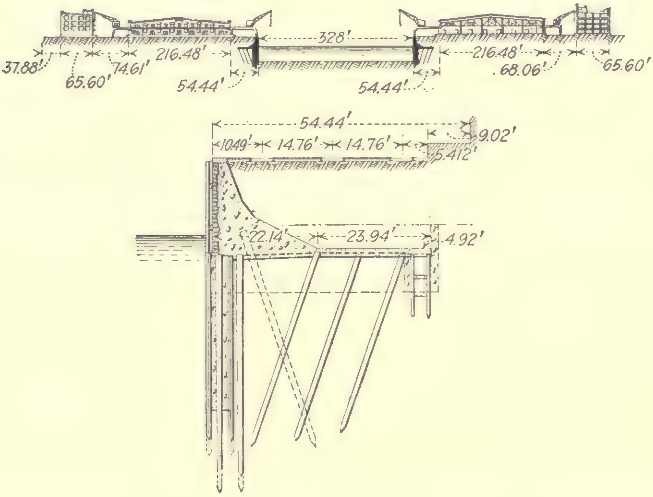


FIG. 63.—Bremen. Section showing quay wall, 3 tracks, wide transit sheds, cranes, marginal street, warehouse (4 floors).

The waterfront tracks are therefore intended for the particular heavy-duty loading as stated. When this kind of freight is not being delivered or forwarded from the water's edge the tracks are kept clear in order not to interfere with the movement of the

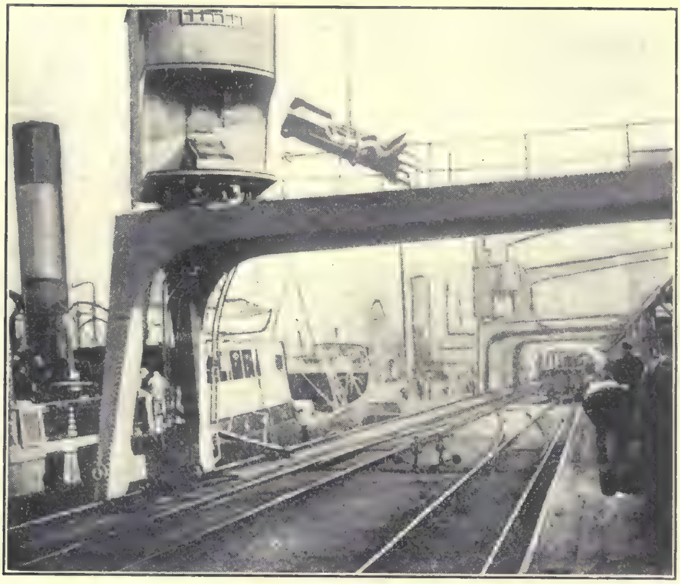
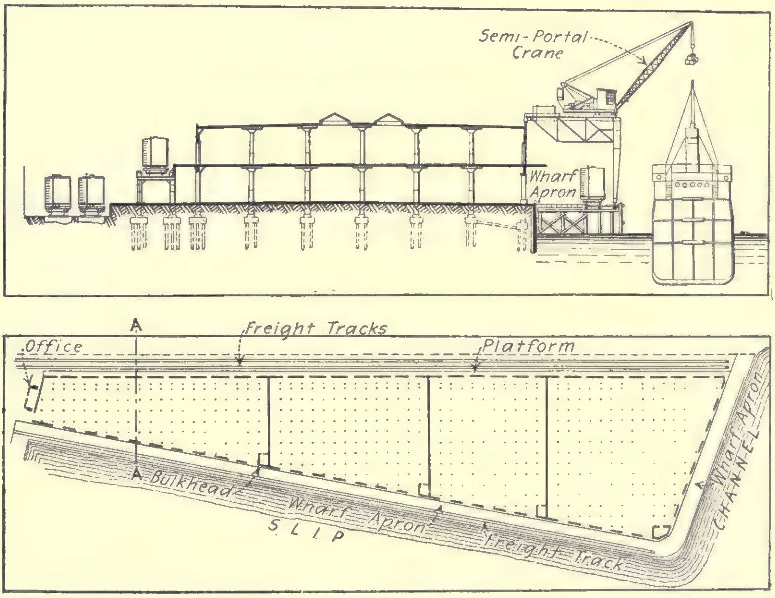


FIG. 64.—Municipal free port at Stettin. View across quay tracks to water's edge from platform. Tracks are not flush with deck pavements, as with the usual arrangement.

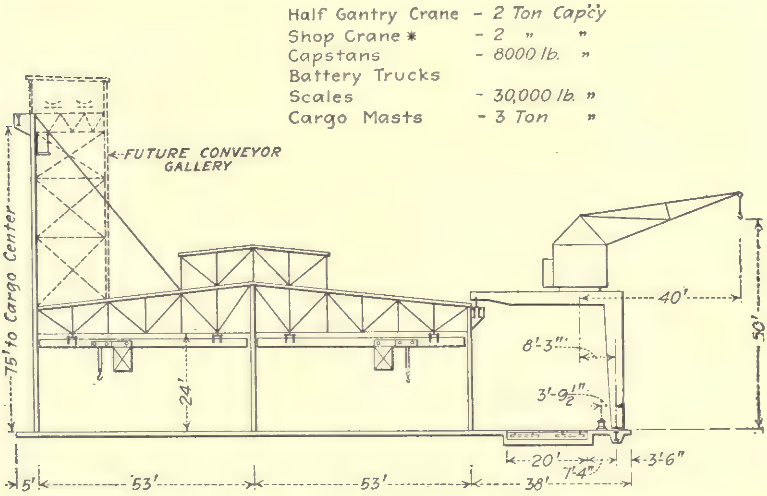


(Ford, Bacon and Davis)

FIG. 65.—Plan and cross-section of Galveston wharf and cotton warehouse.

cranes. The first and last consideration is speed in unloading the ship. After the ship has left the berth the cars may be brought alongside the water side as well as the land side of the transit shed and loaded from the shed door (Figs. 63, 64 and 65).

Cranes Handle Barge Cargo.—After the steamer has discharged its cargo and has gone, barges and lighters come alongside the wharf to take on their freight. These vessels were forced away from their accustomed berth opposite to the ship on the other side of the pier when we put tracks back of the shed and doubled the width of the pier. In the forwarding of freight by lighter and by barge the cranes are now able to perform a great service. After the steamer left, taking its tackle with it, there was no equipment to load onto the small craft. But with cranes on the wharf, they are kept busy in the intervals of unloading ships in handling cargo between the transit shed and the small vessels. This seems to be one of the best uses of the crane. This fact is recognized by Mr. Anderberg and the other Barge Canal Terminal Engineers in designing the canal terminals at New York and in particular the Gowanus Bay Terminal, South Brooklyn. These piers are designed with cranes on the barge side, while the ocean-ship side of the pier is equipped with



(Design Mr. Lawton.)

FIG. 65*a*.—Cross section of the Gowanus Bay. Barge Canal Terminal.—Cargo-mast and grain conveyor gallery on side intended for ocean steamers. On the barge side gantry cranes are provided.

the very efficient cargo mast. The need of crane equipment for all new quays at New York and New Orleans will become increasingly urgent with the renaissance of inland navigation.

The economy of the crane is increased by the fact that it is used not only for the short time an ocean ship is discharging or loading but also during the time in between, while serving the craft which collect or distribute the cargo of the ship. For instance the municipal quays at Hamburg make a charge of about three cents a ton for the use of the cranes. When the freight is transferred from the ship onto the wharf one charge of three cents a ton is collected. When the crane loads part of the cargo from the wharf into lighters or barges, during the time between ships, another three cents per ton is collected. The cranes instead of earning their salt only when working the ship are actively useful when the ship is away. This very simple fact is usually overlooked, the entire attention being directed to the more important movement of discharging the ship. The entire transfer problem of marine terminals needs much more research and analysis than the confines of these pages can do more than suggest.

CHAPTER XI

SHED EQUIPMENT

The movements in the shed consist of sorting, delivery to trucks, drays, cars and lighters, and tiering. All this handling is the source of the largest items of expense. This was seen in the figures given in the chapter on lighterage. It has just been shown above that with ship's tackle the cost of transferring need not be more than five or six cents a ton, and with cargo mast or cranes much less. Some recent and authoritative cost calculations, of handling after the freight had been set down on wharf, from the progressive Port of Seattle, are instructive.

"The cost now runs approximately 100 per cent. more than 18 months ago, because of the high rate of wages paid wharf labor. The average cost of handling Japanese and Chinese merchandise from ship's sling into wharf and piling and sorting is estimated to be 60 cents per ton of 2,000 pounds. For handling gunnies, shellac, hemp and similar articles from India it is 50 cents per ton. Coastwise Alaska traffic consisting of miscellaneous merchandise costs about 30 cents per ton. Traffic rates published by railroad companies for this class of work run to about 25 cents per ton, while private and steamship wharves charge a higher rate."[1]

The Hand Truck.—The chief equipment in freight handling is the hand truck. All efforts are being directed towards the substitution of mechanical means of handling freight on the pier to dispense with the stevedore and the hand truck. Much more improvement will be made if the inventors do not insist on evolving something to do everything with the result that it does nothing well. Our besetting sin is in trying to make one machine a *bonne a tout faire.* For short movements of general parcel freight the hand truck can not be dispensed with. When the movements are longer than 150 feet to 200 feet, then is the time when other machines should be introduced to take the burden and waste of the long haul away from the hand truck. For moving parcels of all sizes and conditions over short distances nothing to date has been sufficiently flexible to be worth while. Therefore let us keep the hand truck for its flexibility and make it work in conjunction with other mechanical appliances which will handle freight over longer distances and when it is exceptionally heavy.

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[1] Statistics furnished by MR. FORMAN, Assistant Manager of the Port of Seattle.

The Electric Truck.—Much attention has been attracted during the past few years by the electric storage battery truck. There has been severe criticism of its performance and much opposition to the innovation. This may be due to several things. The manufacturers, of whom there are several in the United States, have claimed too much for the truck, have tried to make it do too many things and the users have been disappointed. The electric truck has been used on very rough piers where the rather small wheels have been unable to overcome the unevenness and breakage has resulted. In similar manner the ramps into cars and onto gangplanks have been too steep and the joints too rough for the small wheels. It is seldom possible to have the "one man-one truck" organization which would make the stevedore in charge of a truck responsible for its condition. New men each time will have neither skill in operation nor interest in the truck. Then there has been the practice of joyriding instead of walking from one end of the wharf or pier to the other. The principle failure is due to overloading. Trucks have been ordered which were too small for the duty required. There is no economy in overloading any machine, especially storage batteries.

Trailers.—The best hope for the electric truck, in addition to regular operators and smooth decks, is in the entire operation of the trucking. As in the case of the automobile truck the machine is losing money for the owners when it is standing still. Several efforts have been made to eliminate the waiting loss by either trailers or removable bodies. If the work of the truck is to move freight from the pier to the head-house for loading teams, or for other long hauls, one motor can keep three trailers occupied, one loading, one underway, and one unloading.

Skids.—The other principle is that of the removable body. A skid is constructed of stout framework with legs which enable the electric motor to run under it and lift it with its load. Many of these skids may be used. Goods are piled on them when sorted

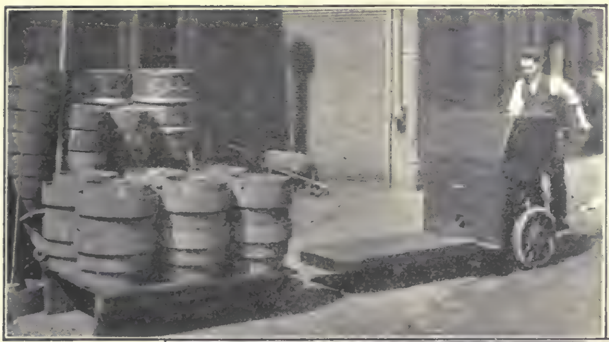

FIG. 66.

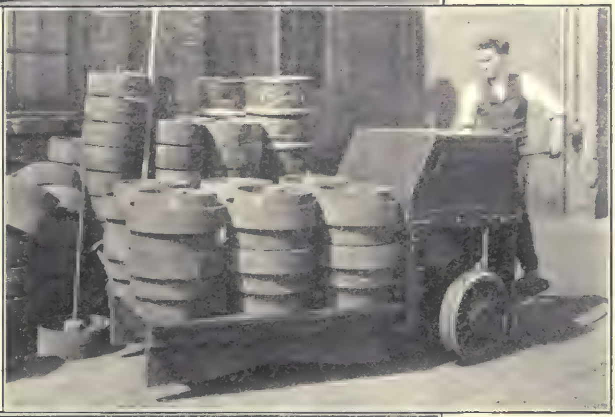

FIG. 67.

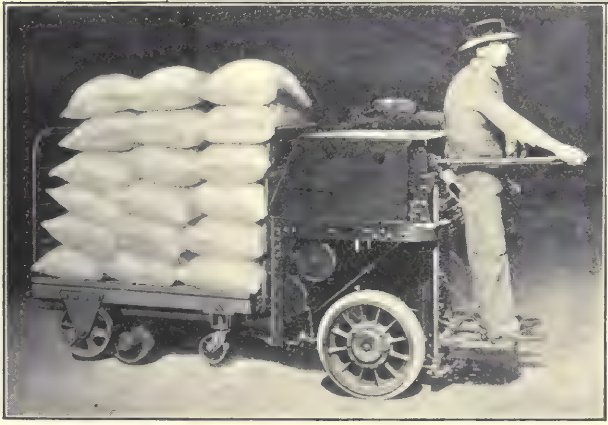

FIG. 68.

(Courtesy of the Elwell-Parker Electric Co., Cleveland, Ohio)

FIG. 66.—I. False platform or skid, loaded and ready for a self-loading truck. VIII–IV–3.

FIG. 67.—The self-loading truck picks up the entire load in 10 seconds. These platforms along the collection route of the electric may require hand trucks for the short movements or picking up the false platforms. VIII–IV–3.

FIG. 68.—A combination of the skid and the hand truck is made in the wheeled platforms. Such a wagon is pushed about collecting a load and when loaded is left standing on the wide aisles or roads along which the electric travels. It is now ready to be moved by electric power for the long part of its journey at the convenience of the electric. Here we have the "reservoir principle" again illustrated. VIII–IV–3.

and held that way in storage until they are called for. The electric truck simply lifts the waiting load and carts it to the waiting dray. In the local movement of loading the skids in the first place and parking them properly to be picked up later the reliable old hand truck does its accustomed duty. The only difference is that the freight is sorted and stored on skids instead of the floor and therefore can be picked up later. It is evident that this system requires considerable shed floor space (Figs. 66, 67 and 68).

A compromise with the hand truck is the hand platform truck or low push cart, which is a skid on wheels. It will be picked up by the electric truck in the same way.

There will still be many queer parcels which can not be handled by these small standardized skids and will have to be moved by hand trucks as formerly. The large majority of general cargo, however, can be handled this way at a great saving.

It is evident from the foregoing that the hand truck or the wheeled platform will work within small radius. The economy of the electric truck will be in the long haul and in keeping busy along the route. The freight on the shed floor should be arranged with this in view and the motor itself kept moving.

Everything still remains to be done in the scientific investigation of the economies of such equipment. There is an endless field for the work of scientific investigators. Engineering and economic seminars will find material for investigation for many years to come. In the meantime, until accurate records are kept, until stop watch and pedometer measurements of freight movements have been tabulated, we can rely only on what data the manufacturers are able to collect. In lieu of these unbiased and scientific data, which future students must collect and tabulate, may be appended some statements from some of the manufacturers which, although honestly intended, can not be considered coldly scientific data. One firm writes,

> "At some of our large installations such as the Morgan Line of the Southern Pacific, New York City and the Panama Canal Zone, where actual costs have been kept, the total charges against each truck including every expense *outside of an operator* is not over 75 cents per day.

"The following data were obtained from actual tests on our machines:

	1	2	3
Material	Pig iron	Miscellaneous freight	Onions
Packed	Bars	Boxes, barrels, etc.	Crates
Weight each	Average 60 lb.	....	54 lb.
Pieces per load	50	....	42 lb.
Weight per load	3,000 lb.	....	2,268 lb.
Total pieces	....	....	540
Total weight	20 tons	46 tons	14½ tons
Distance per trip	300 feet	500 feet	1,200 feet
Number of trips	14	....	12
Total distance	4,200 feet	....	14,400 feet
Labor	4 men	10 men	8 men
Time	2 hours	5 hours	40 min.
Trucks operating	1 El. truck	3 El. trucks	4 El. trucks

The cost of operating a two-ton Hunt Storage Battery Industrial Truck for a period of one year is as follows:

Based on a cost of $1500.00

Fixed charges:

Insurance, interest, taxes, etc., 6%	$90.00
Depreciation:	
Trucks, 10%	$107.00
Batteries, 20%	$70.00
Tires, 20%	$25.00
Repairs	$30.00
Power.—For charging lead cells the rate starts at 30 amps. and finishes at 12 amps. Service 110 volts direct current making the average consumption about 2 kilowatts per hour which for 5 hours would be 10 kilowatts figured at 2 cents per kilowatt hour equals 20 cents per charge. The battery does not have to be charged every day for 5 hours but for estimate we will figure 5 hours for 300 working days making a total cost of 300 times 20 cents or $60.00	$60.00
	$382.00

Recapitulation of Above Tests

"*Case No.* 1. Pig Iron.—Figuring the wages of our men at 30 cents per hour each, would be $1.20, and for two hours, $2.40. The cost of operating the truck as shown above at $1.00 per day of 10 hours equals 10 cents per hour, and for two hours, 20 cents added to above $2.40 makes total expense $2.60 to move 20 tons of material, which is at the rate of 13 *cents per ton.*

"Figuring the same class of material and that one man with a hand truck or wheel barrow carries 400 pounds and requires 15 minutes to load, carry, unload and return, the time required to move 20 tons would be about 30 hours, which at 30 cents per hour would equal $9.00 or 20 tons at the rate of 45 *cents per ton*, showing a saving of approximately 32 cents per ton, not counting the values of speed and time, reducing congestion, etc.

"*Case No.* 2. Miscellaneous Freight.—Forty-six tons moved 500 feet, in five hours by 10 men and three electric trucks. Figure 30 cents per hour for wages, equals $15.00, and three trucks at 10 cents each equals $1.50 making a total cost of $16.50 or at the rate of 36 *cents per ton.*

"Carrying the same material by hand, 25 tons were moved 500 feet in four hours by 11 men which at 30 cents per hour amounts to $13.20 or at the rate of 53 *cents per ton, a saving of* 17 *cents* in favor of the electric truck, not figuring saving in damage and breakage to material and contents.

"*Case No.* 3. Onions.—Fourteen and one-half tons moved 1,200 feet in 40 minutes by eight men and four electric trucks at 30 cents per hour equals $1.60 and truck charges at 10 cents per hour equals 27 cents. Total $1.87 or at the rate of approximately 13 *cents per ton.*

"Figuring the same by hand truck, one man would not carry over four crates at one time making 135 trips, which would require about 30 minutes each at 30 cents per hour equals $20.25 or $1.40 *per ton.* This shows the economy of industrial trucks for material packed in packages, boxes, barrels, etc., which are fairly light but bulky and where the hauls are long.

"The machines are designed and constructed for service on docks, piers, terminals, factories, warehouses, etc., having extra heavy parts throughout. All mechanical and electrical apparatus is made easily accessible by raising one, two, or three hinged sections of loading platform. The spur gear drive has been found to be the most efficient for Industrial Trucks, applying the power as near the periphery of the rear wheels as possible, removing friction and lost motion as common to worm drives and also eliminating chains which pick up dirt and material causing wear, stretching, breaking, and adjustment.

"Half-egg shaped solid U. S. Rubber tires built for Hunt Trucks are supplied, providing greater resiliency and long life and reducing wear.

"Batteries of either Edison or Lead type are provided having ample capacity to operate this machine under normal conditions for a working day of 10 hours. The machines vary in price from $1,500 to $2,500 depending on batteries and size of machine.

"A few of our installations include 67 type A machines for the United States Government, at the Panama Canal, Colon, Cristobel and Balboa; 24 type A & B Morgan Line, S. P. N. Y. C.; 10 type A at Panama R. R. Piers, N. Y. C.; 8 type B at American Dock Company, Staten Island, N. Y.; 24 type A and 24 trailers of two-ton capacity in service of U. S. Army, N. Y. C., Norfolk and Washington; 8 at U. S. Army, Hoboken; 6 at E. W. Bliss, Brooklyn; 10 at Pacific Coast S. S. Seattle, Wash., and San Francisco, Cal.; about 20 in service in ammunition houses in England besides those in operation in various chemical, dye, woolen, bleachery, silk, machinery, automobile and other factories.[1]

To an inquiry made of the Elwell-Parker Co. by the author with an expression of doubt concerning a five-year life for any truck, the following reply was received:

"As to the life of trucks we would refer you to Mr. H. A. Currie, who has charge of the baggage and mail trucks at Grand Central Terminal, New York City, or the operation of the tractors at the American Steel and Wire Plant, Trenton, New Jersey, where three of these have been in 20-hours' daily operation for three years or a normal life of 6 years, figuring on a 10-hour day.

"We have figured usually on a 10 per cent. depreciation and a 10 per cent. maintenance basis. We are convinced that the 10 per cent. maintenance is too high, and we are beginning to believe that the life is going to be nearer 10 than five years. You doubtless understand that the life of these equipments and the cost of the maintenance varies materially with the industries in which they are used.

"We have a tractor in the lumber business in the State of Washington that is handling 3,000 feet of lumber, a distance of 2,000 feet, 50% of the entire day with a cost of $18.80 for its maintenance, where two revamped Fords went onto the scrap heap at the end of the first year doing the same work as this electric."[2]

Imports Subjects to Duty

One example of inefficiency is found in handling imports subject to duty. Here is a case where one of the above mentioned trucking improvements would certainly accomplish a large saving. Take raw Sugar as an example.

1. Raw sugar imported is hoisted from the hold of the ship in slings.
2. Lowered onto small platform hand trucks.
3. Moved by man power a short distance and piled on deck of the pier. The cargo must be gotten away from the fall of the ship's sling.
4. Handled by government men onto government scales.

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[1] Statistics furnished by C. W. Hunt Co., N. Y.

[2] Statistics furnished by Elwell-Parker Electric Company, Cleveland, Ohio.

5. Handled from the government scales to the merchants' scales.

6. Loaded onto trucks and moved to warehouse, drays, Customs, or R. R. cars.

The remedy for the waste movements of (3), (4), and (5) would be to adopt a standard platform truck with the weight of the same clearly marked on it. Then this truck would move onto government platform scales. The tare would be the weight painted on the truck. Merchants should agree to accept the weight of the customs officials. After weighing, the truck would continue its course to the place of loading into the R. R. cars or other conveyances. This system would eliminate many laborers and all the handling at the scales and also the second weighing.

Government, merchants, warehouses and shiplines would save much time and money by coöperating in the standardization of handling equipment to increase the ease and speed of handling and clearing through the customs.

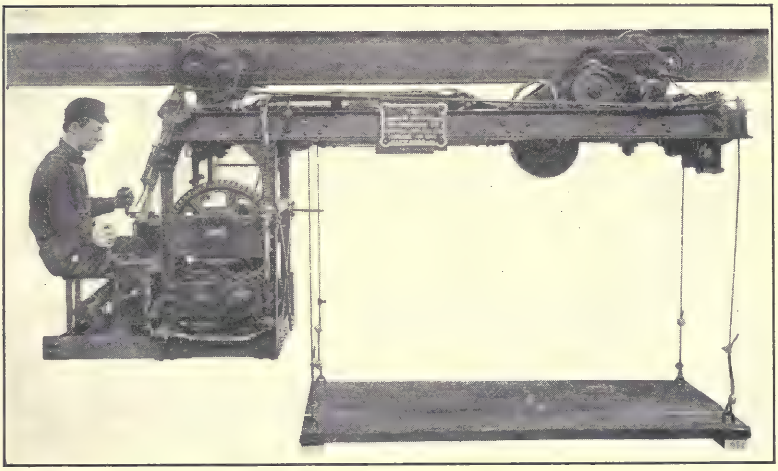
In the case of electric trucks with trailers, the trailers would be used on the scales and not the tractor itself, because of the changes of weight in the elements. The trailer could be made so inaccessible that the chance of tampering with its weight would be reduced to the vanishing point.

There are also simple hand trucks, made to slide under a platform and to lift it by one motion so that it can be rolled to the place desired on the pier deck. The drawback to their use is that the small wheels are inefficient and require great tractive force, even on a smooth floor.

The Telpher or Overhead Monorail Trolley.—Another innovation to reduce the time and expenses of handling general merchandise in the transit shed and elsewhere is the telpher. The system has not fulfilled expectations because of its lack of flexibility, its cost of installation, and primarily because it has been required to do more than could reasonably be expected. However, in the case of standard packages such as sugar, cotton in special warehouses and similar commodities described in a later chapter the telpher has been a decided success.

The first drawback is the cost of construction. Greene puts the cost of a simple system including the increase in the cost of the pier shed structure to carry the load at $50,000. In a plan never carried out for a Philadelphia pier each side of the pier had five longitudinal tracks and five pairs of crossovers and fifty switches. The cost of the installation would have been more than $100,000 (Fig. 69).

All these tracks were made in order to have the overhead carrier reach every part of the pier deck and eliminate the hand truck. As stated above this elimination is neither practical nor desirable. Only where there is intended to be a large movement of goods capable of tiering and requiring tiering in the transit shed is this desirable. Even in this case the portable conveyor would do the work when needed at a fraction of the invested capital. Where the telpher has been successful has been not in the transit shed at all but in warehouses, such as the Chalmette Sugar Refinery and the Municipal Cotton Warehouses at New Orleans, where goods are not tiered in transit but in storage.



(Courtesy of Brown Hoisting Machinery Co.)

FIG. 69.—Brownhorst 2-ton, two motor electric I-beam man trolley, for handling miscellaneous packages, at Los Angeles, Cal.

The movable loop has simplified the telpher system for tiering. The Sprague system is the most advertised. In the place of attempting to cover the entire floor area with overhead tracks and crossovers the shop crane arrangement is applied. A shop crane is a bridge spanning the width of the shop between two heavy rails, one on each wall. The bridge moves along these rails and can span any part of the shop. On the bridge is a cage and hoisting machinery which travel the length of the bridge across the span. The movements of the bridge and the movements of the hoisting cage enable every point on the floor to be covered. The loop telpher simply takes over this system and by making the bridge carry connecting curves and switches the hoisting cage can leave the bridge and, travelling along the side rails to other connecting rails, pass out to the loading bridge of the wharf or to the warehouse. Where tiering is to be accomplished and not mere lateral travel this simplified system seems capable of development. Yet, let it be again added, tiering in transit sheds is to be countenanced only when there is no room for the lateral expansion of the shed. In the warehouse the telpher system has already demonstrated its value.

The same principle applies to the telpher system as to the electric trucks. On a long pier, where the freight must be moved down the pier to waiting drays at the head-house to meet the drays and keep them off the pier, *i. e.*, in service where there is long haul, mechanical movement is necessary. With the construction of a simple trunk line of two overhead tracks down the middle of the pier, standard hand platform trucks—low push carts—can be used for the short motion. The loaded hand trucks may be moved to the center of the pier under the trolley to be picked up by the man in the cage and moved rapidly through unoccupied space to the head-house for delivery to the dray calling for the consignment. The application of the trunk line telpher system to the system of removable bodies, motor trucks, and store-door delivery as described under "Drayage," seems to be one of the most promising solutions of mechanical freight handling on piers.

The accent is put on piers. When the shed can be reached by dray from the back and from its long side instead of the end, the travel will be too short to make the overhead telpher economical. The electric truck and skid system probably would still be economical in most cases. The saving accomplished by electric trucks over the old hand method would not always pay the capital investment, in the short cross shed movement. In the case of long narrow piers the problem is entirely different. The further success of these efforts to substitute machines for muscle in moving freight along piers will be followed by all with the keenest interest.

CHAPTER XII

THE WAREHOUSE

The pier shed is the reservoir to hold a shipload for one sailing. That is why we call it a *transit* shed. The warehouse system is the reservoir for the entire port for months and seasons. The present collapse at the ports is due not only to the fact that the transit sheds do not hold a full cargo, but also to the insufficiency of the warehouse space to hold any overload of traffic.

Thus we have two functions of the warehouse, the economic or time function, and the traffic or physical storage function. To these may also be added the financial function.

The economic function of the warehouse is to create time utility. The warehouse makes it possible to catch up the supply which is in excess of the demand at the harvest and preserve it until such time as the supply tends to be less than the demand. Cold storage of perishable food products is an example. In fact the cold storage warehouses and markets should be a coördinated part of every regulated port. Coffee, grain, etc., are also stored against time.

Amount of Warehouse Space.—Mr. H. R. Geddes, a famous English expert in ports and freight handling matters, told the author that the Antwerp authorities figured on a warehouse capacity of 1½ times the cargo capacity of the port. However, at points which are to serve as reservoirs for particular harvests with an exceptionally high peak load during the movement of the season's product, this capacity may not be sufficient. Again we face a problem for the research activities of the serious scientific student. The thesis would be, what warehouse capacity is required at the chief ports for certain world commodities? Sugar at Havana, coffee at Santos, wool at Sydney, and grain at Odessa or at consignment markets such as London, Liverpool and New York would be among the cases studied.

The important function of the warehouse at great consignment markets such as London will be discussed under the heading of "Free Ports."

Fiscal Aspects of the Warehouse.—The position of the warehouse in financing shipments of merchandise is most important. It has been the practice of centuries to *lombard* or hypothecate goods in warehouses to banks for loans to carry the merchant until such time as the merchandise is sold. The system was thoroughly developed by the Italian merchant cities of Lombardy a thousand years ago. A warehouse, with the confidence of the bankers that the merchandise will not be changed or removed, can issue warehouse receipts or warrants to the merchant storing his goods in it. The merchant can borrow from the bank on surrender of this warehouse receipt to the banker. The receipt gives the bearer title to the goods. If the warehouse is under governmental control and inspection, or owned outright and operated by the port authority or the municipality, the security of the warrant is increased.

The nature of a warrant or warehouse receipt is illustrated by an example from the public warehouses of the Port of New Orleans. The system is of far reaching economic effect on the production and marketing of commodities.

Negotiable Public Warehouse Receipt

Board of Commissioners of the Port of New Orleans

Cotton Warehouses

New Orleans, La............19..   Receipt No..........

Received on Storage in the warehouses above described................ bales of cotton bearing the tag numbers and marks shown hereon, to be delivered to......................on order only on the surrender of this receipt properly endorsed and the payment of charges accrued thereon.

The maker of this receipt shall not be liable for any damage or loss caused by fire.

The maker of this receipt has no ownership in the cotton covered hereby nor any claim against the same except a lien for charges. The rates of storage or other charges on the cotton covered hereby, for which a lien may be claimed are as shown on the reverse side hereof.

For the Board of Commissioners of the Port of New Orleans

Note.—This receipt is not valid unless for the Board of Commissioners of the Port of New Orleans, by its receipt clerk, certified by its Recorder and countersigned by its Deputy Manager.

........................Receipt clerk,

........................Recorder,

........................Deputy manager.

The Construction Details of Warehouses.—There are two principal types of warehouses, the one story and the many storied types. The single storied warehouse is built to accommodate certain merchandise which is inflammable or which requires handling and tiering machinery to move it economically. The single storied warehouse usually has a high roof and the merchandise is tiered. This is the case in certain sugar, coffee, seed and in particular cotton warehouses. The new Municipal Warehouses of New Orleans are examples of the very best practice of cotton storage. This method was adapted after careful study of many systems here and abroad. The prototype is found in the very successful warehouses of Manchester with many improvements and adaptations to local conditions.

New Orleans Cotton Warehouses.—Formerly it was necessary to haul cotton by drays from railroads and steamboat landings to the yards and from the yards to the steamships, a slow and expensive process. The centralized cotton storing is to avoid draying in the first instance. In the new warehouses draying is abolished and rail, river, and ocean carriers are coördinated.

The first definite action toward the establishment of a state-owned warehouse was Act. No. 133 of 1910 of the Legislature of the State of Louisiana. The powers were further amplified by an amendment to the state constitution in 1913, known as Article 322. According to the provisions of these enactments, the money with which to build the new warehouses was to be supplied by the issue of $3,000,000 worth of 5% bonds.

When completed, these municipal warehouses will have a railroad yard with a storage capacity of 1,000 cars on 20 miles of track. A telpher system of overhead transfer with 18 feet of headroom was installed, and elevated tracks and trailers were provided. Buildings G, H, J, and K consist of 124 compartments, each 100 feet × 30 × 40. Each compartment will hold 1,600 bales of cotton stored ten high in four tiers. The four warehouses together will store 200,000 bales.

The compress room is 200 feet by 400. It has a sawtooth roof to give ample light. Ten thousand bales of "flat" or uncompressed cotton may be stored "on the head" in this room until they are compressed.

The latest installation of a "Standard" high density press will enable cotton to be compressed to a density of 33 pounds to the cubic foot as compared to a former density of 22 pounds.

The bales of uniform size will be 48 in. by 24 by 20. This means a saving of 15% to 20% in ocean freights.

The wharf is 2,000 feet long by 40 feet wide and is equipped with a two-track belt line. The wharf house is 1,513 feet long by 138 feet wide. It is built in two stories and has a capacity of 75,000 bales "on the head."

Weighers, samplers, and inspectors are appointed by the New Orleans Cotton Exchange and officially represent that body, so that certificates issued by them are accepted as official. Thus the duplication of work by both buyers and sellers is avoided.

Because of the concrete construction and the installation of sprinkler systems, the rates of insurance are low, amounting to only about 25 cents per $100, or about 15 cents a bale per year. There is a point, however, beyond which further reduction in the insurance rates is not sufficient to cover an increase in the costs of construction and of fire-preventing devices.

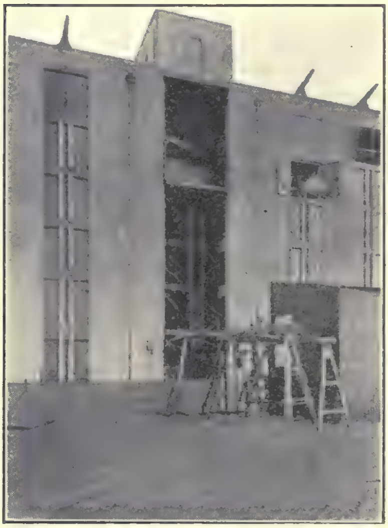


FIG. 70.—Warehouses and whip hoists at the Bush terminal.

The many storied warehouse is the usual type for general merchandise. The building is of staunch fire-resisting construction with frequent fire walls and no elevator shafts if possible. Where there are elevator shafts inside the building its walls are massive and the doors are of the most improved fire-resisting construction. The floors of a many storied warehouse are close together, usually at a distance of eight to nine feet. The object here is not to have head room for tiering but to have as much floor area as possible to prevent tiering. Warehouses may vary from three to thirteen stories at various European ports. The usual practice here and abroad is five or six stories.

The most approved hoisting or elevating machinery is not the usual lift or elevator as in factories and loft buildings, but the fall rope outside of the building. One system is the electric warehouse hoist with a drum and motor and controller in the roof space with a controlling lever at each floor served by the fall rope It has been found to be more economical than the elevator.

The other is the so-called "whip hoist" with the winding drum in front of the building instead of under the roof. There is no control lever on the floor, but the control is exercised by the man operating the drum in front of the building who has full view of what is going on. The whip hoist is the method used at the Bush Terminal. Electric hoisting winches are placed on the marginal way in front of the warehouse and about 75 feet distant from it. From the winch, lines run over the blocks above the warehouse door. One winch can operate four or more lines. Loads are hoisted directly from the marginal way under the warehouse opening to a little above the level of the opening and then are swung into the warehouse floor. Eight hundred bags of coffee averaging 130 pounds have been raised by a single whip in an hour[1] (Fig. 70).

FREIGHT HANDLING AND SHIPPING IN RELATION TO THE WAREHOUSE

Rail Connection.—The location of the warehouse in relation to the other carriers is of the greatest importance. The aim should be to eliminate the use of the dray for every movement to and from the warehouse except that of local delivery.

One handsome set of London warehouses has only dray connection with no other means of transportation. Many of the Liverpool warehouses must cart every pound of freight to and from their doors. This is a fearful economic waste. But at Liverpool as at New York these conditions have been a bad heritage from pre-railroad times. On the other hand the goods house of the London, Tilbury and South End Railway is an example of the best intensive development of the modern railroad freight terminal in direct connection with the Tilbury docks, linking ships, transit shed, and railway net (Figs. 71 and 72).

The Calvin Tomkins plan for the West Side of New York went a step further and applied the principles of intensive freight house development to the marine terminal warehouse. The result is a freight warehouse with direct rail connection from the ground floors, with the transit shed of the steamship pier by means of a

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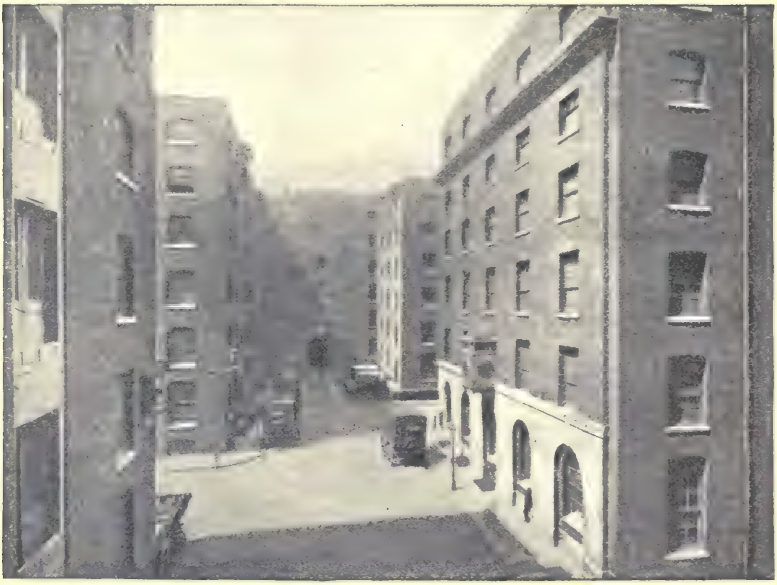
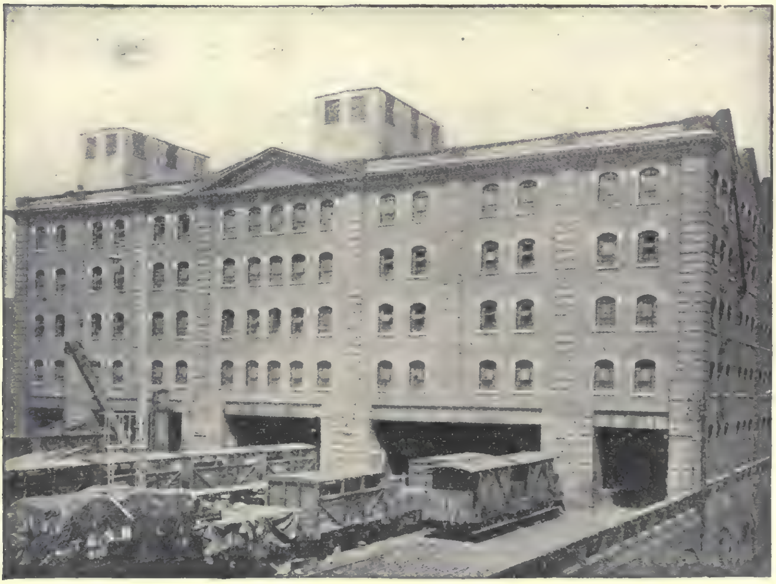
[1] B. F. Cresson, Jr., *Report on Mechanical Equipment of New York Harbor*, New York, Dec. 19, 1912.



(From Report of Conn. Rivers and Harbors Commission, 1910)

FIG. 71.—Cutler street warehouses, London—covering an area of 5½ acres.



(From Report of Conn. Rivers and Harbors Commission, 1910)

FIG. 72.—Commercial road warehouse, London. Built over the goods depot of the London, Tilbury and Southend Railway, and designed for traffic to and from the Tilbury Docks.

short spur track, and with the truck railroads by belt line, and whose loading facilities for local cartage are ample. A similarly planned many storied warehouse over the freight yard is nearing completion in Chicago for the Pennsylvania Railroad. The structure is not only modern in equipment and of enormous dimensions but architecturally a marvelous edifice. The day of the open freight yard and the isolated warehouse is past. Urban freight terminal yards now occupy only warehouse basements. Cupples' Terminals at St. Louis are a notable example. Also at the Bush Terminals the rail, pier, and dray coördination is accomplished.

Warehouse Location with Respect to the Wharf.—At Bremen, Stettin, and elsewhere the warehouse has been located directly back of the transit sheds and across a marginal driveway from them. Goods intended for the warehouse are trucked across the shed deck to the rear where the crane picks them up and sets them on the floor of the warehouse where they are to go (Fig. 73).

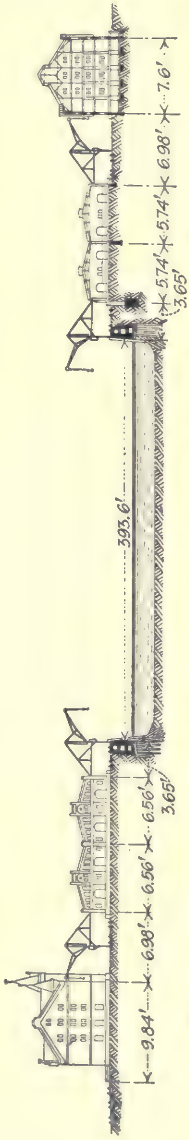


FIG. 73.—Cross-section of Bremen basin showing arrangement of cranes, sheds, and warehouses.

This seems very good in theory, but let us look at the situation more closely. Suppose that a merchant keeps his stock all together in a warehouse "A" and a ship with a consignment for him docks at wharf "F" a mile down the quay. It will be necessary to cart the consignment a mile along the waterfront. The warehouse might as well be a mile inland. The carting is the very thing which it was sought to avoid by locating the warehouses directly behind the transit shed. This fond hope of unloading directly from ship to warehouse is blighted by the experience of every one who has tried it.

The first modern quay at Hamburg was opened in 1866. The first municipal warehouse in the harbor fitted with rails and cranes was built in 1872. It was located a few feet from a deep water quay wall as it was expected that seagoing ships would berth alongside the quay, and discharge directly into the floors of the warehouse. This was soon found to be impractical as, with few exceptions, all cargo must be spread out on a roomy shed floor to be assorted according to marks. As ships increased rapidly in size this sorting became less possible and the chances of discharging directly from ship to warehouse decreased. On reflection it is evident that the chances are not great that very much of a general cargo of merchandise will go into the particular warehouse opposite that particular ship at that particular time.

The warehouses of Rotterdam, Amsterdam, and many other ports, are located on the waterfront (Fig. 74). They are built in the place of a pier shed a street width or even only 20 feet back from the water's edge within reach of long-arm jib cranes. Some are connected by a bridge spanning the marginal street. In cross-section drawings of such warehouse quays, the water end is usually indicated by the section of a large ocean ship. This is misleading as no ocean ships will discharge miscellaneous cargo at such a quay unless they are charter ships carrying one kind of cargo for one kind of warehouse, as for instance a cargo of tobacco for several large importers located in the great tobacco warehouses and all together. In the case of the cotton warehouses at New Orleans or the coffee warehouses at Santos, where the usual thing is to load entire cargoes of cotton or coffee, there is a notable exception to this rule. What happens at Rotterdam with the great warehouses or the waterfront is this. Ships at mooring posts or quays elsewhere in the harbor send the merchandise consigned to the warehouses by lighter and do not unload at the warehouses themselves. This has been fully described under the discussion of lighterage, and it has been shown that warehouses may be located anywhere on the harbor waters where it is possible to build water connection on one side of them,

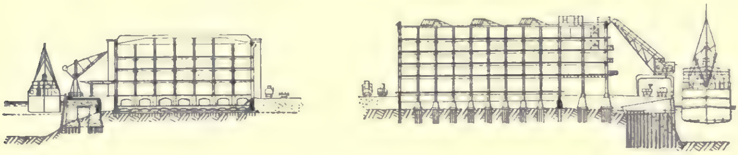
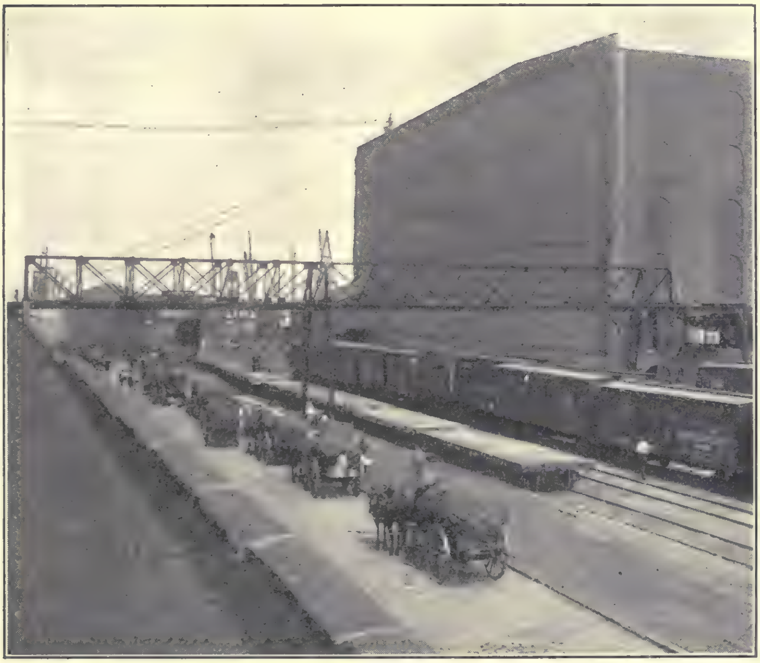


FIG. 74.—Rotterdam warehouses.

to enable the draying movement to be accomplished by lighter, the more efficient and economical vehicle.

The warehouse, therefore, should have complete rail connection with the interior and complete lighter connection with the remainder of the harbor waters. Thus every warehouse will be given complete coördination with every railroad and with every ship without using the dray except for local delivery of small amounts of freight.



(Courtesy of the Brown Hoisting Machinery Co., Cleveland, Ohio)

FIG. 75.—A warehouse of the New York Dock Co., with physical connection with the waterfront across a marginal street and railroad through unoccupied space by means of a man trolley monorail telpher.

When waterside location is not possible—and no warehouse should occupy deep water front at any time if ship berths are decreased thereby—there must be access to the waterfront. Under no condition should any organization or individual be permitted to occupy the waterfront alone to the exclusion of the upland with its possibilities for industrial and warehouse development. When, as in the case of the ground about New

York, excavation of lighter canals to accommodate warehouses with water connection is impracticable, some other sort of connection between wharves and warehouse must be designed.

In Brooklyn the New York Dock Co. uses a telpher to establish physical connection between the transit shed and the warehouse across a marginal driveway and railway. Direct connection of some sort is an absolute essential (Fig. 75).

At Bush Terminal about 30 per cent. of the incoming freight from the ships is destined for the warehouse. It is hauled there by low horse-drawn trucks. One horse will keep three trucks under way, one loading, one moving, and the third being unloaded. Mr. Bush has found the horse truck more economical than the electric truck with trailers. The former with three trailers cost $500, the latter $2,500.

The warehouses on the upland are absolutely dependent upon the waterfront connection even if only by mule-drawn lorries. Take away the waterfront and the upland is worthless. The entire success of the Bush Terminal has been this coördination between waterfront, ships, railroads, and warehouses, which is not found on Manhattan, and the lack of which costs the American shippers so many unnecessary millions.

Storage Sheds.—The Cresson system as proposed for Camden and Bayonne, New Jersey, introduces a new idea, that of the combination of transit shed and warehouse space. Every 600 feet along the bulkhead platform there are placed above the single storied bulkhead shed two more stories to act as warehouse space. These are called storage sheds in contradiction to transit sheds and to warehouses.

Experience has shown that it is necessary to provide for the storage of freight in addition to the short time storage which can be accommodated in the bulkhead sheds. These storage buildings are generally similar in design to the bulkhead sheds, with many doors, and fully equipped with sprinklers, with no attempt at fire-proofing the sides or the roof, and with cargo hoists or brackets to facilitate the handling of cargo. The storage shed is designed to accomodate demurrage freight, lost packages and other cargo not removed promptly from the pier.

A notable departure has been made in the design of these sheds by setting back the shed on the second floor five feet from the line of the bulkhead shed, and by setting back the third-story shed five feet from the second-story shed, so that there will be a platform on which to land cargo and from which to receive cargo, and for operators. This practice, while it is not general in this country, is extensively used abroad. Many of the storehouses in London, for instance, are built in this manner.

The cross section of the three-story shed is shown on drawing, Fig. 76. The lower floor will be for the protection of commodities in transit where they can be handled directly between ships and trucks and railroad cars. The second and third stories extend over the railroad tracks and are intended for storage and warehousing. The ten-foot platform to the rear will make it possible to handle commodities between the warehousing and storage floors and railroad cars or trucks without their coming into the pier sheds at all. This is a rather novel design and, it is believed, will effect economies in storage. Commodities can be taken from ships and stored and then loaded into railroad cars or into trucks, without the necessity of any intermediate drayage, and without having to pass through a congested pier or bulkhead shed.[1]

The Cresson storage shed is valuable for accommodating demurrage freight or freight which for some reason or other must wait longer than three days and must be put some place out of the way. At New York and elsewhere demurrage freight is carted to warehouses and the expense is charged to the shipper by the transportation company (steamship or railroad). These charges amount to millions of dollars a year, an expense which would be reduced to a minimum by some such plan of accommodation. On the other hand, no one should be misled into thinking that general cargo destined for warehousing would be loaded from ship's hold to warehouse deck in any such simple manner. Like every other such plan the Cresson storage shed is a welcome innovation to accomplish a very definite and circumscribed piece of work.

Foreign Warehouses.—A description of the extent and nature of the warehouses at the three great ports of London, Rotterdam, and Liverpool, quoted from the report for 1910 of the Connecticut Rivers and Harbors Commission is here appended.

London.—Cutler Street Warehouses are the largest of the group, and are situated near Houndsditch and Bishopsgate Street. They occupy 5½ acres of ground, and are provided for the reception of the more valuable classes of goods. The principal

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[1] *Report on Proposed Marine Terminal and Industrial City at Bayonne, N. J.*, by B. F. Cresson, Jr., 1917.

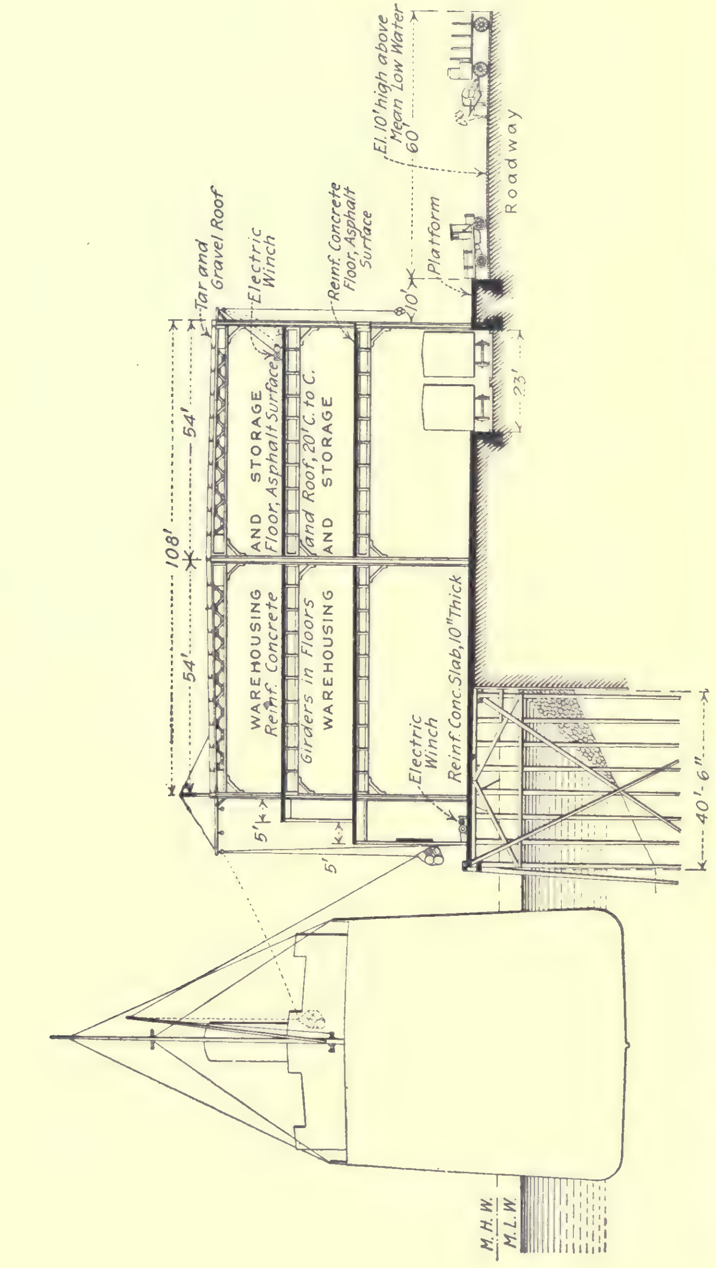

Tar and Gravel Roof
Electric Winch
Reinf. Concrete Floor, Asphalt Surface
El. 10' high above Mean Low Water
60'
Platform
10'
Roadway
108'
54'
54'
WAREHOUSING AND STORAGE
Reinf. Concrete Floor, Asphalt Surface
Girders in Floors and Roof, 20' C. to C.
WAREHOUSING AND STORAGE
23'
Reinf. Conc. Slab, 10" Thick
Electric Winch
5'
5'
40'-6"
M.H.W.
M.L.W.

FIG. 76.—Cresson type storage shed. A good arrangement for accommodating demurrage freight or other short time storage.

articles are tea, Oriental carpets, chinaware, and japanware, silk, silk and cotton piece goods, ostrich feathers, fancy feathers and bird skins.

Crutched Friars Warehouse is situated in Crutched Friars, and is used for cigars, cigarettes, furs, drugs and other articles of value.

Commercial Road Warehouse is situated at the City end of Commercial Road, is built over the Goods Depot of the London, Tilbury and Southend Railway, and was designed for the accommodation of traffic to and from the Tilbury Dock. All classes of goods are dealt with, the chief being Indian and Ceylon tea.

West Smithfield Cold Air Stores, in St. John Street, the more recently constructed of the Town Warehouses, is for the storage of refrigerated meat, etc. It adjoins the Smithfield Meat Market and provides accommodation for 100,000 carcasses of sheep.

Rotterdam.—The port of Rotterdam is poorly supplied with warehouse facilities, there being but one on the water's edge. This is perhaps largely due to the old prevailing custom of storing goods in the lower part of the merchant's private houses which are especially built for this purpose.

These are the four kinds of bonded warehouses in Rotterdam, subdivided according to the control exercised by the custom house authorities:

1. The Free Bonded Warehouse.
2. Private Bonded Warehouses.
3. Fictitious bonded Warehouses.
4. Warehouses, not controlled by the custom house authorities.

The free bonded warehouse is an institution managed for the account of the municipality under the supervision of a Board of Control, some members of which are appointed by the Queen. The custom house authorities keep constant watch over these bonded warehouses. The free bonded warehouses are two in number. The custom house authorities superintend the carrying of dutiable goods to these bonded warehouses. The duties need be paid only when the goods leave these establishments.

The private free bonded warehouses are intended for goods liable to a high excise duty, such as spirits, wine, etc. These warehouses are in private hands but are entirely under the control of the customs officials, so that they must be built in accordance with their regulations, and nothing can be either stored or cleared without their coöperation.

The fictitious bonded warehouses are for goods liable to low duties, such as petroleum, cottonseed, tobacco, mineral waters, etc. The custom house authorities confine themselves to controlling the quantities stored from time to time. These warehouses, therefore, possess the same advantages as the other kinds without their drawbacks as regards continual supervision.

Warehouses not controlled by the custom authorities, therefore, contain either goods that come in free, or goods the duties on which have been paid.

Liverpool.—*The Mersey Docks and Harbor Board*, the port authority of Liverpool, does an enormous storehousing business, special warehouses being provided for the principal classes of goods as follows:

Opened	Warehouses	No. of floors	Quay frontage, linear feet
1846–7	Albert Dock Warehouses	Vaults, quay, ½ deck, and 4 floors above.	2,169
1854–5	Stanley Dock Warehouses	Vaults, quays, and 4 floors above.	633
1856	Wapping Dock Warehouses	Vaults, quays, and 4 floors above.	753
1858	Birkenhead Dock Warehouses	Vaults, quays, and 1 floor above.	518
1875[1]	Morpeth Dock Warehouses	Vaults, quays, and 3 floors above.	166
1867–8	Waterloo Grain Warehouses	Quay, and 5 floors above.	1,385
1868–9	Birkenhead Grain Warehouses	Quay, and 5 floors above.	2,176
1869	Composite Warehouses	Quay, close shed, and 4 floors above.	276
1877[1]	Wallasey Dock Warehouses	Quay, close shed, and 2 floors above.	1,200
1896	Wool Warehouse, Gt. Howard Street	Vaults and 2 floors above.	
1900	Stanley Dock Tobacco Warehouse	Vaults, quay, 12 floors above.	625
		Total..................	9,901

[1] The whole of the Morpeth Warehouses and Blocks B & C of the Wallasey Warehouses now form part of the Birkenhead Foreign Animals Wharf and are not available for general traffic.

The new Stanley Dock Warehouse for the storage of tobacco is one of the largest storehouses in the world. It is 723 feet long, 165 feet wide, and 13 stories (about 125 feet) high. It is of fireproof construction, being built of brick and steel with concrete floors. Over 27,000 000 bricks and 6,000 tons of iron were used in its construction. It has a capacity of over 60,000 casks of tobacco in single tier without piling.

Warehouse Ownership and Operation at Hamburg. The Mixed Corporation Principle.—By 1858 the needs of the harbor had grown so acute owing to the rise of the interior, demanding coal and other raw products, that action was necessary. The Hamburg Chamber of Commerce therefore decided to investigate the needs of the Hamburg merchants, and sent out an inquiry sheet to several hundred leading merchants, shippers, brokers, ship agents, ship builders, skippers, and others practically interested in harbor development. The result was the report of the year 1858 which, to all intents and purposes, settled nearly all of the questions of harbor policy as we know it to-day as far as the larger schemes are concerned. One question was that of the warehouses.

The discussion of 1858 firmly established the principle that every one of the harbor facilities from the basins dug by the municipality to the quays, sheds, and warehouses, must be prevented from becoming the monopoly of any one group of individuals. So far as the quays and mooring posts were concerned, the solution was not so difficult, but when it came to the building and operation of warehouses, public opinion was not ready to support municipal ownership, and yet there was a firm conviction that such important institutions as the warehouses should be under state control. The result was another compromise which was not carried out until the shakedown resulting from the controversy about Hamburg's admission into the Tariff Union in 1888.

This compromise was the formation of a privileged stock company known as the Free Port Warehouse Company, upon the following conditions. The warehouse company was to build and operate the warehouses in the municipal harbor. The area occupied by the warehouses in the general plan of the harbor was to be capitalized at 500 marks per square meter (about $12.50 per square foot) paid for in stock. This made the municipality a large stock owner in this privileged company. The company guaranteed in addition to pay an annual rent of 17.50 marks per square meter, about 40 cents per square foot on a 50-year lease. The municipality also is to participate in the profits of the undertaking as follows: After all expenses, including interest on bonds, amortization, etc., 3½ % of the capital stock is to be paid to the stockholders; if further profits accrue above this 3½%, ⅝ of this 3½% is to go to the city; if further profits are forthcoming, up to 1½% of the capital stock will go to the shareholders; above this ⅝ of 1½% goes to the municipality, and if still further profits are made by the undertaking the municipality and the shareholders divide in the ratio of 5 to 3. As will be seen, the city has provided for ample participation in the profits of the warehouse company. These profits are devoted to harbor improvements and in this way are given back to the public.

Other Examples of Municipal Coöperation.—This same principle of coöperation between private persons and the municipality of Hamburg has been applied to various activities in the harbor. We have space enough to mention only a few.

One is the establishment of coffee houses called the Volkskaffeehallen which are halls for rest and refreshment for workingmen in distant parts of the harbor. The city has gradually built more than sixteen such restaurants, the buildings have about 1,200 square yards of floor space and cost about $30,000 to build. The plant is then turned over to a certain eleemosynary institution which runs soup kitchens in poorer sections of Hamburg, and this society takes over the entire operation of each hall. They pay the municipality a rental calculated at 3½% of the cost of the plant. In 1913 there were 500 seats in each of the various halls, which together served 602,000 meals during the year, 1,000,000 portions of potatoes, 1,000,000 portions of soup and vegetables, 3,000,000 cups of coffee, 150,000 glasses of milk, and more than 100,000 bottles of mineral water. One of the conditions upon which this society took over the operation of the hall was that no alcohol would be served.

In other ways, also, private business has found it convenient to work with the municipal government. For instance, after the Hamburg-American line outgrew its original quarters in the America Quay, it turned to the city government for new quarters, whereupon the city government built three new basins with all the necessary accouterments, including two miles of quays, 1,500,000 square feet of shed room, a mile of mooring posts, and nearly 125 acres of water area. The plant cost the municipality of Hamburg 43,000,000 marks or about $10,000,000. The plant was then rented to the Hamburg-American Line on a 25-year lease at 1,300,000 marks per year, which is about 4% on the investment.

As another example, in 1899 the Stettin Machine Building Company, "Vulkan," planned to move their shipyards from the Baltic to the North Sea. Hamburg and Bremen competed for first choice because such a large business enterprise would be an asset to the city. Hamburg won by offering to build the necessary water accommodations for the shipyards. They leased 50 acres of land and water to the company for 25 years at 12 cents a square meter for the land area and 4½% of the investment in improvements, which cost the city 7,000,000 marks to build. The "Imperator" was built in this new area. The capture of this shipyard is considered by Hamburgers as well worth the price because of the additional trade and activity it brings to the city. The municipal harbor may well be a star attraction to bring new industries to a port city.

CHAPTER XIII

STANDARD PACKAGE OR SPECIALIZED FREIGHT

Terminals which handle a large tonnage of freight of the same kind lend themselves readily to labor-saving machinery. There are two classes of specialized freight, package and bulk. Illustrations of uniform package freight are coffee, sugar, seed, rice, etc., in bags, paper in rolls, crates of fruit, bananas in bunches, cottonseed cake, and many other commodities of similar character. Bulk materials are coal, ore, petroleum, grain, in fact any materials in liquid form or in comparatively small pieces. The two groups present two different mechanical problems.

The general principles of port layout are as effective in the case of either group as in the case of miscellaneous package freight. There is transference between ship and land, there is the transit storage shed to hold the cargo awaiting the ship or to take the cargo as quickly as discharged, and there is the larger reservoir, the warehouse. The warehouse for specialized freight may vary from the usual type used for general package freight to great tanks of bulk oil, grain elveators, or the stock pile of coal or ore. These "warehouses" are constructed to accommodate a particular commodity. The stock pile is a warehouse.

Bulk or specialized freight offers an opportunity for the continuous-motion principle, while in general package freight there is little hope of getting away from intermittent motion. Any commodity which may be pumped, like liquids or grain, or moved by belt conveyors, like coal, or by package conveyors, like bananas, boxes of apples, and bags of coffee, affords an opportunity for economy through mechanical ingenuity.

Transfer Movement.—Little progress has been made in the development of continuous movement of bags or bales from ship to shore. The reason may be that the crane has been developed to such efficiency that it has not been necessary or very profitable to design continuous-movement unloading machinery. Bags and crates unloaded through hatches are lifted in the rope sling by boom or crane and deposited on the wharf deck for handling.

In some cases, notably at Santos for coffee loading, the conveyor has a movable section permitting it to be extended to the deck of the ship where the bags of coffee are fed to the slings which lower a sling full at a time into the hold. At Santos the horizontal travel from warehouses to shed and to ship is done by means of belt conveyors which are built along the outside of the building.

Banana Unloaders.—The method of handling in slings did not work well for bananas as the fruit was bruised. As the banana trade increased in importance throughout the world the terminals of banana steamers at Hamburg, New Orleans, and elsewhere were fitted with a specially devised banana unloader. The most succsseful type and the one with the greatest capacity has been installed by the Port of New Orleans, the Port of Galveston, and elsewhere. The equipment is described as follows, in a booklet issued by Ford, Bacon and Davis, the engineers designing the municipal wharves, warehouses and elevators at New Orleans, La.

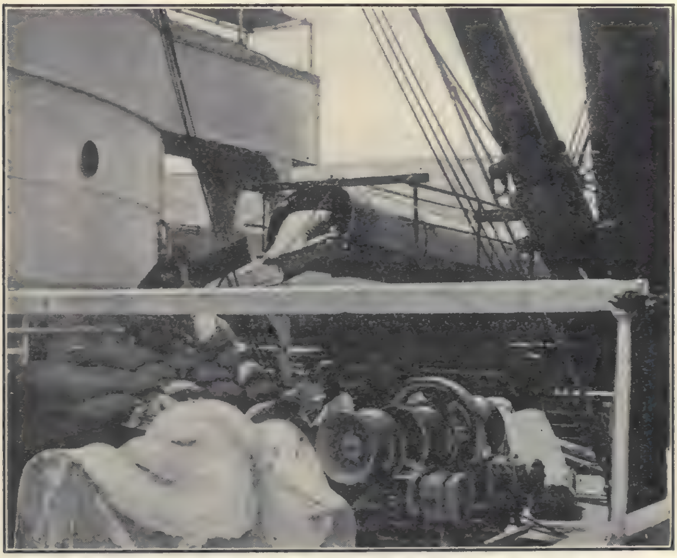


FIG. 77.—Belt conveyor at Santos. Loading coffee from warehouses to ship.

Banana importations at New Orleans exceed those at any other Port, amounting for the year ended June 30, 1914, to 16,583,000 bunches, equivalent to an average of 320,000 bunches per week.

The handling of this business by mechanical devices has been developed until practically all of the bananas are now unloaded by machines.

The design of this machine is complicated by the necessity of providing for a wide range of water level and ships of various dimensions. The machine consists of a steel "A"—frame structure traveling lengthwise of the wharf on two rails about 21 foot centers, and carrying a structural steel main boom 50 feet in length, stepped about 20 feet above the dock level.

"On this boom, at a distance of about 30 feet from the heel, is stepped an auxiliary boom 20 or more feet in length, from the end of which is swung the vertical leg of the conveyor. These two booms afford almost any desired combination of vertical and horizontal adjustment, while at the same time the main boom is sufficiently short to clear the stays and wireless rigging of the ships.

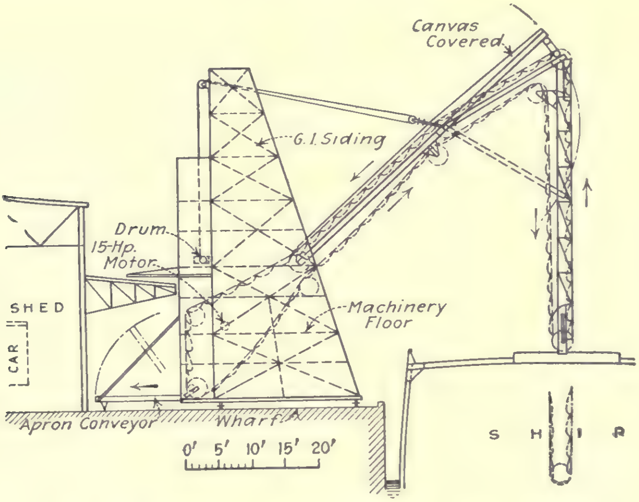


FIG. 78.—Section of a banana unloader at New Orleans.

"These booms and the frame work carry the conveyor proper, consisting of two endless chains spaced about five feet apart and running over pairs of sprockets at the foot and head of the conveyor frame, at the pivot points of the auxiliary and main booms and at additional points at the discharge end of the unloader, as shown in sketch (Figs. 78 and 79).

"The distance between chains is maintained by pipe spreaders and through bolts spaced about three feet centers, attached to which is a four-foot canvas belt with sufficient slack between each pair of spreaders to hold a bunch of bananas when the chain is moving vertically.

"Upon reaching the point of discharge the bunch is forced out of the pocket by a roller behind the belt and drops upon a short horizontal conveyor from which the bunches are picked up by hand, inspected, sorted and loaded into cars, or disposed of locally.

"The entire machine is driven through gearing and clutches by one 15-H.P. motor. The capacity of each machine is upward of 2,600 bunches per hour.

"Three groups of these unloaders, consisting of 10 units, are owned by the Dock Board, the total investment being about $90,000. The most recent installation is at the Pauline Street wharf and consists of four machines costing approximately $37,500. The section of the wharf on which they operate is of pile and timber construction with steel shed, about 360 feet by 260 feet. As the area is covered rain does not interrupt the discharging of cargo. The wharf is served by eight transverse spur tracks accommodating five cars each, and as one ship may carry 40,000 to 45,000 bunches or about 120 carloads, the entire track capacity may be filled and moved three times in less than a day's time. The cost to the Dock Board of this wharf with its shed and tracks

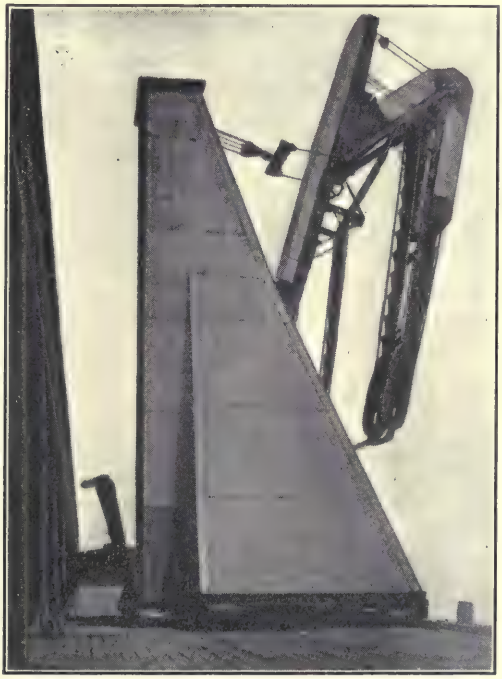
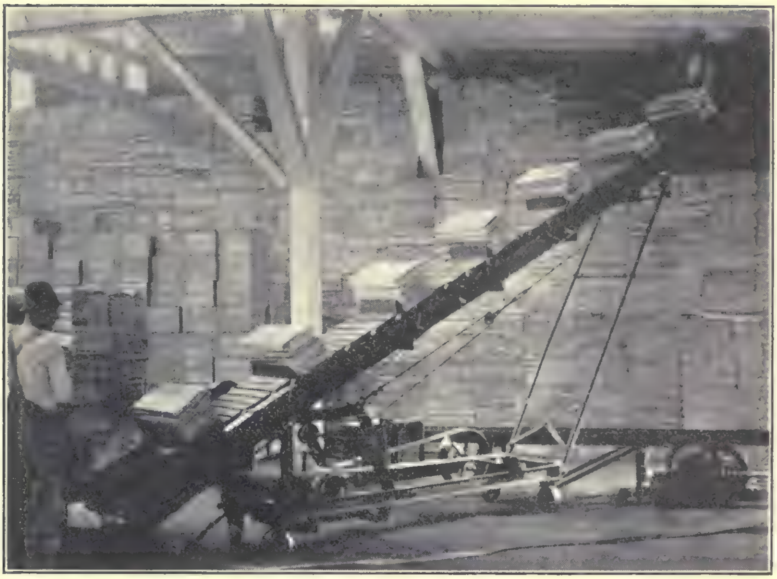
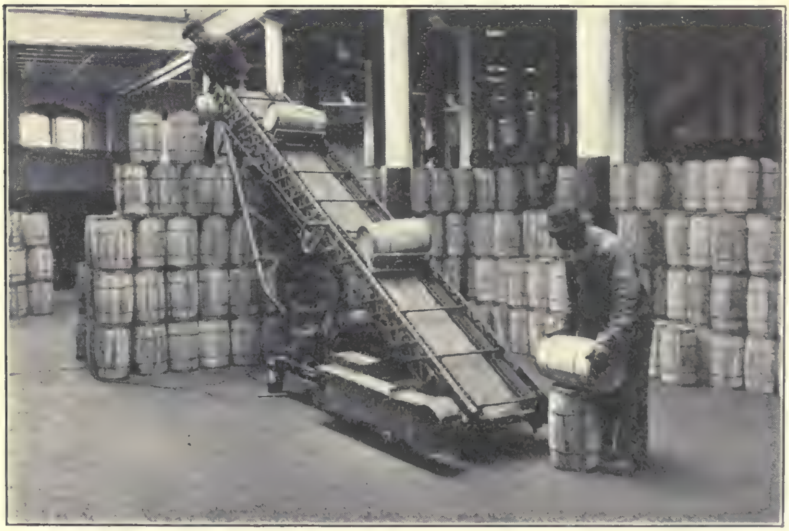


Fig. 79.—A banana unloader at New Orleans.



(Brown Portable Conveyor Co.)

FIG. 79*a*.—Portable tiering conveyor for uniform packages.



(Brown Portable Conveyor Co.)

FIG. 79*b*.—Tiering barrels with a portable tiering conveyor.

was about $1.40 per square foot. In the rear of the wharf the Public Railroad has yard capacity for 200 additional cars.

"The Board of Commissioners makes a charge for the use of the banana conveyors of one-fourth cent per bunch, which considerably exceeds the cost of operation, maintenance, and interest charges."

Vertical Belt Conveyors.—The principle involved in the banana conveyor, that of the slack belt between rigid cross pieces and the three-ply leg to make possible accommodation to the variable depth of ships and water-level, is suggestive for other unloaders. It is perfectly feasible to unload coffee or sugar bags in the same manner. In fact, any regular bag- or bunch-shaped articles which will not injure the belting could be handled by this apron, or slack-belt system. The increase in the speed of unloading by the mere feeding of single bags to an elevating conveyor is very marked. The great trouble heretofore has been that conveyors would work horizontally and at a low grade, usually not exceeding 45%, but could not possibly perform a vertical lift and a horizontal transfer.

Horizontal Conveyors and Tiering.—After the freight has reached the deck of the wharf it is handled by efficient machines which have been devised to take care of its further movement. It has been pointed out that the chief expense at the terminal is in what we call "handling," that is, moving across the pier, tiering, breaking down the tier, loading into drays or railway cars, and moving to the warehouse. In the case of miscellaneous freight with the wide variations in the size, weight, and shape of the parcels, there has been little relief by mechanical means and the hand truck reigns supreme. However, when it comes to specialized freight there are already many tried and proved devices, products of several firms and nationalities.

The first movement is horizontal, across the deck. The belt conveyor, either portable or stationary, is well known. Other methods we discussed above. In the horizontal movement the saving over man and hand truck accomplished by machinery is not as great as in the second movement, which is tiering. But tiering is pure muscle, undiluted brute force. Even the hand truck by comparison is a labor-saving machine not to be despised. It must be borne in mind that tiering is necessary if, for instance, the cargo of coffee for a ship is to be held ready in a shed of reasonable dimensions. To tier to the height required to husband space requires a large force of men. The tiering is done on the pyramid plan with the ledges or steps about a yard high. Each ledge requires a workman to hand the bag of coffee to the next higher ledge. Therefore every additional yard in the height of the tier means an additional man and as many handlings as the stack is high. The tiering elevator is the solution. They have been successful wherever built by reliable firms. One case in point is the great sugar-beet seed farm at Klein Wanzleben near Magdeburg, where the beet seed in bags ready for shipment is held in large warehouse sheds with rail sidings. There are often as many as 300,000 bags of seed tiered to a height of from 40 to 50 feet by portable electric elevators. When the railroad box cars are to be loaded the tiering machine and portable conveyor running in the reverse direction help to break down the tiers and move the bags into the box car. Our American machines are at least as efficient.

Tiering or stacking elevators should embody several features. Such a machine should deliver the packages at a rate which will keep the men at each end moving at an efficient speed. As one illustration a stacker for oil cake delivers three cakes at a time every six seconds. Another delivers a 160-pound bag every eight seconds. These are rather slow machines. A speed of two seconds would require a rather large force of men at the delivery end to dispose of bags arriving at the rate of 30 per minute. The problem, as is the case almost every time, is to design the machine for its special duty. The elevator should be in several joints to afford greater flexibility in storage and in operation. The motors and moving parts should be well protected and simple in construction. The units should be as light as is consistent with stability, to make shifting about the shed as easy as possible. In this connection the diameter of the wheels should be as great as the design of the elevator will permit, to overcome tractive resistance in shifting the machine. There should be some means of locking the castors or wheels when the machine is in operation.

The operation of portable conveyors may be clearly seen from the illustrations. A saving of as much as 80%, in some cases, is credited to these machines.

Telpher.—The other method of lateral and vertical movement is the telpher. At New Orleans the Chalmette Sugar Refining Company has used the telpher with success. This transfers from ship to shore, then to shed or warehouse, and also does tiering. We have familiarized ourselves with the telpher and found that for miscellaneous package freight it was not sufficiently flexible in most cases, and its use had been a failure in such instances. However, in the case of specialized freight, the telpher has been a success. As usual, from the standpoint of operating economy, the volume of materials moved must be great in order to "dilute" sufficiently the fixed charge of the expensive installation.

Telpher System, Chalmette Sugar Refinery.—New Orleans receives large quantities of raw sugar from Cuba, Porto Rico, and local production districts. The American Sugar Refining Company alone receives over 300,000 tons per annum at its large Chalmette refinery, just below the city.

This plant has a well equipped telpher system for receiving, storing, and delivering raw sugar. This system operates between a wharf about 80 feet by 800 feet parallel to the river, and a storeroom about 250 feet in the clear from the wharf.

The wharf is a pile and timber structure with columns set on piles and double hardwood floor laid on a packed sand bed. The column spacing on the wharf is approximately 20 feet both ways, while in the storeroom the spacing is about 20 feet by 25 feet. Both structures are enclosed with galvanized iron and the two are connected by four elevated runways, for the telpher system, which are also entirely enclosed.

The track system for the telphers is divided into two sections, each consisting of a loop on the wharf and four loops in the storeroom. The telphers can be operated selectively over any of the loops of a section by means of a transfer or switch which connects the tracks, as desired. The two track sections can be interconnected by a special transfer or switch cutting off a large part of the run when ships are unloading at suitable points.

The telpher equipment consists of 25 machines; each has a capacity of seven bags of sugar weighing about 330 pounds each, or about one long ton, and is equipped with two travel motors of six horsepower each, on a swivel truck, and one hoist motor of five horsepower. The telphers travel 700 feet per minute, which enables them to pick up their load, make a round trip to the storeroom, discharge therein, and be on the wharf ready for another trip within five minutes.

The storeroom has a maximum capacity for storing sugar of about 370,000 bags or 52,500 tons, each panel between four columns containing approximately 2,500 bags when tiered 28 bags high.

Sugar arriving by boat is practically all in bags. The bags are unloaded from barges or boats by three small electric derricks on the outer face of the wharf, and from ships by the ships' tackle, in both cases being deposited on the uncovered portion of the wharf. The bags are then placed on trucks in lots of two or three and trucked to a portion of the wharf which is in reach of the telphers; in the case of imported sugar, they pass over the Government scales on the way. On this floor the bags are sampled and weighed for settlement with the seller, again made up in slings, and transported by the telpher to the storeroom and there tiered as already described. When sugar is to be used, the same telphers remove the bags from the tiers and deposit them at the shore end of the storeroom where they are sampled and weighed for controlling the manufacturing process. At this point the sugar is removed from the bags and is carried by bucket elevators to the refinery.

The estimated capacity of this telpherage system, as outlined, is 3,000 tons per working day of ten hours, or 75 tons per hour per machine.

An auxiliary storage system consists of two smaller sheds located at the lower side of the main storage shed and served by an electric industrial railway which crosses under the telpher runs, where the loads are received by the cars. The tiering in these sheds is done by portable stackers.

Eight spur tracks provide facilities for bringing in or reshipping sugar by rail.[1]

The transfer of cotton bales from the warehouse to shed and to ship is done by a telpher system in the new Municipal Warehouses at New Orleans. Few commodities require such a large reservoir as cotton, because the cotton crop comes on the market with a rush to be drawn off throughout the rest of the year. Ships can not take it away as fast as it is produced. The reservoirs should hold a large part of the crop to guard against the calamity of a sudden shipping disturbance. Moreover, the cotton warehouse is a specialized warehouse designed to meet the peculiarities of the cotton trade.

Standard package freight handling, therefore, is being successfully solved by mechanism vs. muscle. In the case of bulk freight the greatest progress has been made, and the United States excels all other countries.

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[1] Pamphlet by Ford, Bacon and Davis.

CHAPTER XIV

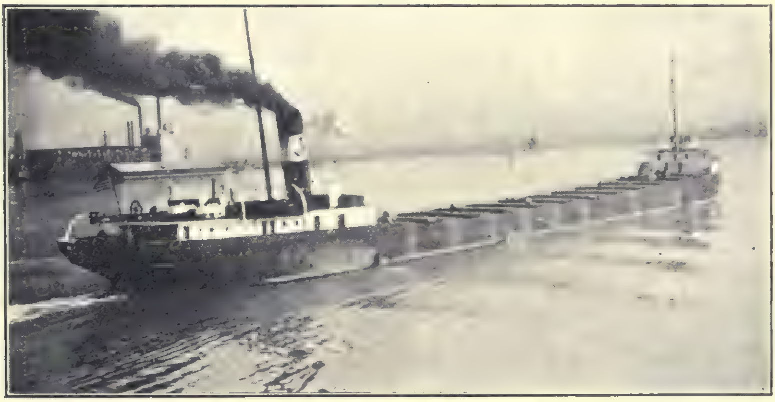
BULK FREIGHT

Coal and Ore.—The factors of transfer, transit storage, and warehousing are the same for bulk-freight handling as for package freight, but of course, their applications are different for different products. The main element of the warehouse or reservoir in bulk freight is the stock pile. Likewise provisions for holding the cargo on the pier in readiness for quick transfer into the hold of the vessel are a vital point. The ore or coal pier looks very different from a general merchandise pier, but its function is the same. One difference between ore or coal piers and general cargo piers is that the former require different design according to whether they are to be used for loading or unloading. By the very nature of the traffic, ore or coal movement over a pier is all in one direction, and besides, even if it were not so, loading and unloading require quite different equipment. Therefore, we have to consider (1) the stock pile (warehouse), and (2) the (*a*) loading pier, and (*b*) unloading pier (transit wharves).

The favorable load factor has been a peculiarly fortunate circumstance in developing the Great Lake traffic. Ore and grain come down while coal goes up, thus balancing export and import.

Special Carriers.—The needs of the heavy industries, which have grown to greater magnitude here than in any other country, coupled with the high wages prevailing, have developed not only the loading and unloading facilities but the carriers as well. While the Mississippi River steamboat has remained unchanged, the lake barges have been transformed from the most inefficient form of water freight carriers to the most efficient. The result, of course, is that the Mississippi River long ago ceased to be a transportation factor in the nation's economy, while the movement of ore, coal, and grain on the Great Lakes became of the utmost importance (Fig. 80).

The modern carrier on the Great Lakes has a capacity of from 8,000 to 12,000 tons of ore or coal. A steamship has been evolved with the power plant far aft, the forecastle in the very bow, and all the space in between unobstructed hold. The hatches are separated only by the width of the thwarts which are spaced 12 feet between centers. The spacing of 12 feet is uniform on the Lakes and is almost as important as the standard gage of a railway. This type of vessel has a direct connection with the port facilities. All the loading bulk cargo, and the loading mechanism is designed for a 12-foot spacing. There are no bulkheads or compartments in the hold. Sometimes there are as many as forty hatches but the usual number is between twelve and thirty.

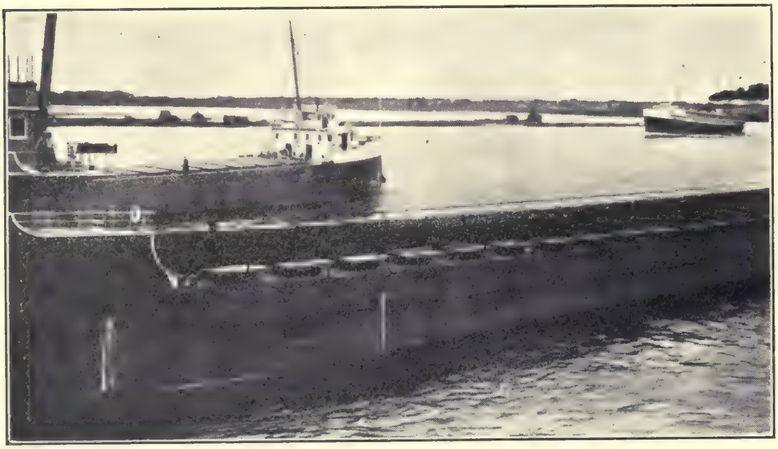


(Photo by author)

FIG. 80.—A typical lake steamer with twelve hatches, on the St. Clair river.

The pier which has been developed to the highest degree and which is the most generally in use is the trestle and pockets system. A modern ore pier at Two Harbors, Minn., will serve as an illustration. This pier is 1,368 feet long and 56 feet wide. The narrow width compared to a general merchandise pier shed, is due, of course, to the fact that the material extends to a great height instead of being spread out on a floor. The pier carries a trestle 80 feet high with car tracks on the top; cars run from the storage pile or railroad yard over 114 pockets on each side of the pier. The pockets are 12 feet wide and each has a capacity of 350 tons of ore. Ore cars 24 feet in length dump into two pockets. It will be seen that pockets, cars, and ship hatches are of corresponding dimensions and will therefore register. The pockets are loaded from the railroad storage yard or the storage piles by running the train of cars out onto the trestle over the bins and dropping the ore through the bottom of the cars. In this manner the "transit shed" is loaded directly from the cars, and holds the cargo awaiting the arrival of the vessel.

When the vessel arrives it berths alongside the trestle. Its 12-foot hatches are all open (Fig. 81) and registering with the spouts of the 12-foot pockets or bins. The sluices of the pockets are opened and in a very short time (23 to 45 minutes) the vessel is filled. The spouts are movable in a circle of a few feet to permit the material to be directed to all parts of the hatch, therefore trimming is almost entirely eliminated.



(Photo by author)

FIG. 81.—Another view of a lake steamer, with hatches open.

One conspicuous example of a loading trestle is the Duluth ore pier of the Missabe & Northern R. R. It is 2,146½ feet long, 64 feet wide, and will load 15 vessels of 8,000 tons capacity at one time.

Unloading.—Unloading has not been brought to the same degree of efficiency, as the record on the Lakes of 2½ hours unloading for a 10,000 ton vessel compared to 23 minutes for loading it will show. Loading is an affair of gravity. Once cars are pushed onto the 80-foot high trestle the further operations are only the controlling of the gravity feeds. However, when unloading, until there is a ship dumper designed which will lift the ore vessel and turn it over and spill out the cargo, as is now done with a 100-ton car, there must be designed ever more efficient and rapid systems of elevating machinery. The improvements which have been made in thirty years have cut the cost of discharging an ore ship from 56 to 4 cents per ton. The history of this achievement by one who has lived through the period of its development was given by Mr. Carey at the Cleveland meeting of the Association of Port Authorities. In substance he gave the following account:

Development of Bulk Unloading.—In the early '80's two methods were in common use to unload ore: (1) with a horse and block and falls, hoisting about one-half of a ton of ore in a bucket through the hatch to the height of the runways, where two men would drop it into a barrow and one wheeled it to the "dock;"[1] (2) with an engine with drum and three falls, arranged to hoist all at once from three different hatches.

Next came the McMyler whirler, a revolving jib crane, which lifted a one-ton bucket of ore from the ship to the car or "dock." It was a revolving derrick, and had two buckets. As one was being loaded by a shovel in the hold, the other would ride up above the deck. When the volume of ore began to increase and the necessity of stock piles became imperative, Mr. Alexander Brown evolved the Brown Hoist and Bridge. This mechanism contains three machines which travel along a rail on the front wall of the "dock," and on a back rail in the rear of it. Practically bridging the space between the two, extending arms come out along which the buckets run on a carrier to the ore pile or unloading cars where they may be needed. This new device cut in two the cost of depositing the ore in the stock pile, as well as saving much of the time required (Fig. 82).

The next improved device, the one which is in general use to-day, is the Hulett "grasshopper" unloader. Beginning with the idea that the use of the hand-operated shovel would have to be eliminated in order to gain any material increase of speed, Frank E. Hulett in 1898 perfected a line bucket which was to sink its cutting jaws, while open, into the ore to the depth of about a foot, and then come together on a plane surface. The "grasshopper," which is now in wide use, consists of a massive frame, or walking beam, whose front end rests on the face of the dock, and the rear end on a slightly raised concrete wall. On this frame is a carriage moving backwards and forwards over the ore trough. At the outer end of the walking beam we find the legs, which reach down into the hold. The whole mechanism

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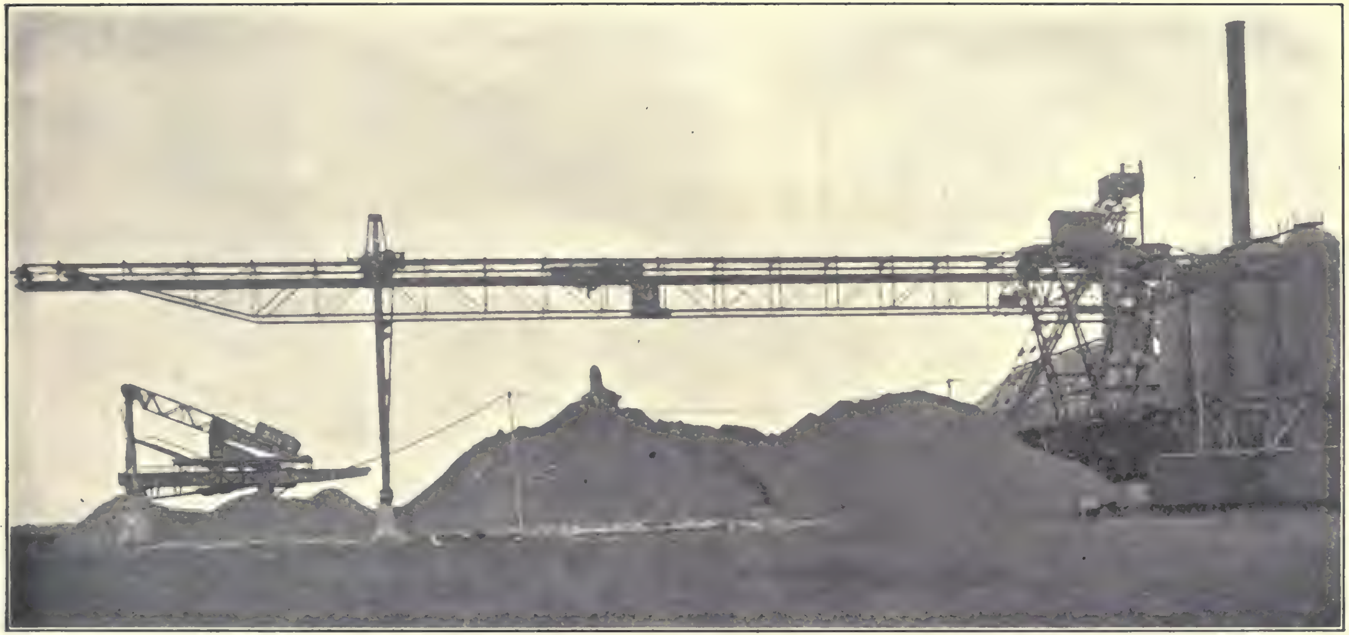
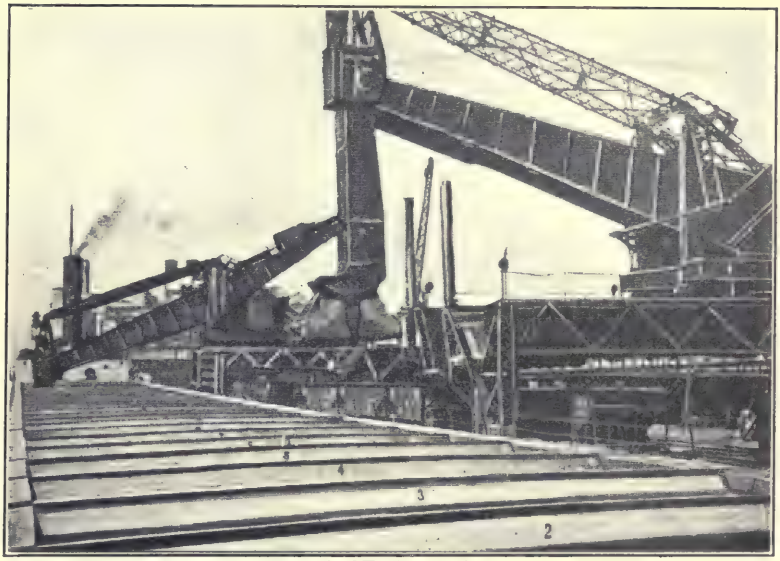
[1] On the Great Lakes the word "dock" is always used to mean some kind of a wharf and not the water beside the wharf.



(Courtesy Brown Hoisting Machinery Company)

Fig. 82.—Ore-handling bridge crane, used by Wickwire Steel Company.—Ore is moved from the wharf edge (transit pile) to the stock pile ("warehouse") by the bridge. Actual transfer from ship to wharf is done by the Hulett "grasshopper" unloader, on the left.



From "Freight Handling and Terminal Engineering")

Fig. 82*a*.—Giant unloader at work unloading ore at Genson street dock, Buffalo.

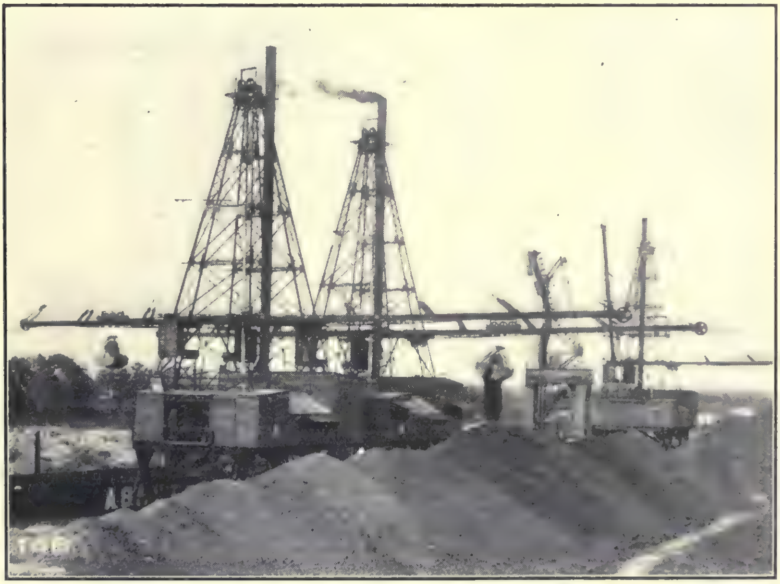


Fig. 82*b*.—Unloading from coal scow to stock pile. Three steam clamshell outfits. The "goosneck" between No. 2 and No. 3 is a continuous movement conveyor coal bunkering barge.

is operated by one man. Underneath the main frame and running along the bottom are the weighing hoppers. When a load of ore (15 to 20 tons) is elevated by the bucket clear of the vessel, the carriage runs back on the main frame until the bucket is over the weighing hopper or the ore trough, and there the load is released. The weighing hopper moves only between the main legs of the machine. A cable runs alongside of each track continuously, and the movement of the cars is taken care of by the cable. An operator pulls a lever on the mechanical clamp which is attached to the train and moves the car or the train one-half a car-length for the next load. The stretch of the buckets when they are open is about 22 feet, and they carry a load of from 15 to 17 tons. They average about 45 seconds to the load.

The cheapening of the cost of unloading by the successive steps by which the process was improved between 1880 and the present may be shown by the following comparison:

Cost of unloading a ton of coal with barrows.	56 cents
With Brown machine and shovelers.........	28 cents
With Brown fast plants..................	12 cents
With Hulett fast plants..................	4 cents

Self-unloaders.—A type of Lake boat has been developed which is fitted with mechanical equipment for unloading its own cargo. The advantage of this boat is that it can call at ports not fully equipped and unload small or large amounts with its own equipment at a very low cost. One boat recently built by the Great Lakes Engineering Company for the Wyandotte Transportation Company will serve as an example. She is 439 feet long over all, 56 feet beam, has 21 hatches, and will carry from 6,000 to 8,000 tons of cargo at a speed of 12 miles an hour. Inside she is built with two long hoppers in the shape of a flat "w" with the sides at an angle of 35 degrees. Under the two lower points of the "w" are two 42-inch pan conveyors. These conveyors move the material forward. At the bow the conveyors rise and discharge into a cross chute which itself discharges into a 42-inch discharging conveyor boom with a radius of 67 feet. This conveyor will pile the material 52½ feet from the sides of the ship at an angle of 90 degrees. The mechanism is driven by two 150-H. P. engines. Such a boat can discharge at any place where there is a wharf for a minimum cost at the rate of 600 to 700 tons an hour[1] (Fig. 83).

Unloading from steamer to freight cars is less frequent than from steamer to stock pile. The importation of ores from Cuba, Spain, Northern Africa, and Sweden is increasing. Therefore this movement is coming more into evidence. There is much unloading from boat to cars in the case of coal. However the movement from the mines in the first shipment out is the more important.

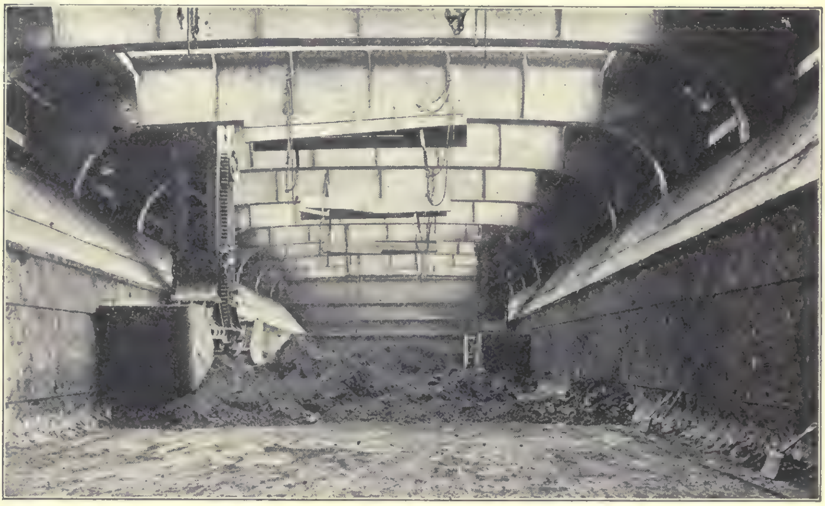


FIG. 83.—Leg of Hulett unloader in boat.

An example of an apparatus made for unloading from ship to cars is the McMyler unloader, in Fig. 84 which shows two machines at the Girard Point Terminal of the Pennsylvania Railroad, Philadelphia. The two machines are unloading the Swedish ore steamer *Tordenskjold, Tonsberc,* into cars. The machine consists of a tower 96 feet high. The base is a full gantry spanning two railroad tracks. Forty-nine feet above the level of the wharf is the track on which the grab or scoop buckets of three and two tons capacity respectively work the cargo from ship to hopper. The buckets travel along a track one-third of which is built solid in the tower. The remaining part is a movable boom which is hoisted to a vertical position to avoid fouling the tackle when moving the ship. The hopper which feeds the ore into the hopper cars acts as a reservoir. The boom-and-hopper principle is a usual arrangement for all bucket and transfer track installations. This one has a reach of 45 feet beyond the face of the wharf. The capacity at 120 cycles an hour, a round trip every 30 seconds, is 200 tons.

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[1] International Marine Engineering, Oct., 1916.

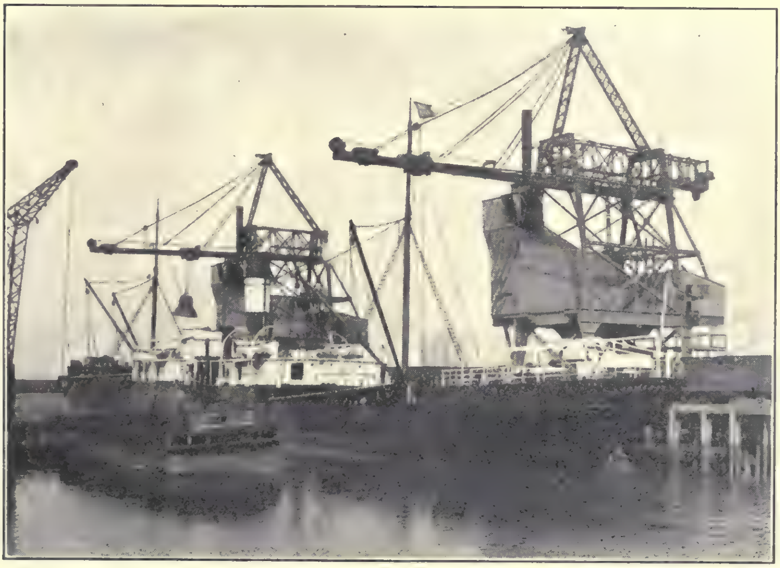

FIG. 84.—McMyler unloader at the Girard Point Terminal of the Penna. R. R., Philadelphia, Pa.

Loading ocean-going vessels, which are deeper and have only four or five hatches, is a much more difficult problem than loading Lake boats. There has been a tendency toward the all-hatch collier and ore steamship, but it has met with the difficulty of longitudinal rigidity in its construction for ocean service, and the fact that charters as well as liners carry various kinds of cargo as the occasion arises. Also, the greater depth of hold and the fact that material must fall almost vertically has made the dumping method for piece coal unsatisfactory because the coal is broken. The latest development in the marine coal pier for loading coal into ocean vessels has been the Stuart Belt Conveyor. For the sake of clarity before describing the Stuart system a distinction must be kept in mind between the export coal pier which is designed to load colliers and coal-carrying cargo boats, and the equipment for loading into lighters for delivery to local consignees or for bunkering ships at their berths.

Perhaps the largest export coal pier yet constructed is the one finished recently for the Baltimore and Ohio Railroad at Curtis Bay, Baltimore. This is of the Stuart system of continuous motion by belt conveyors and is revolutionary in the results obtained. The new pier has a capacity of 12,000,000 tons a year whereas the maximum capacity of the old pier is 2,500,000 tons. Coal is an important item in the freight moved by the B. & O. Out of a total of 69,000,000 tons revenue freight in 1904, 36,000,000 tons were coal and coke (Fig. 85).

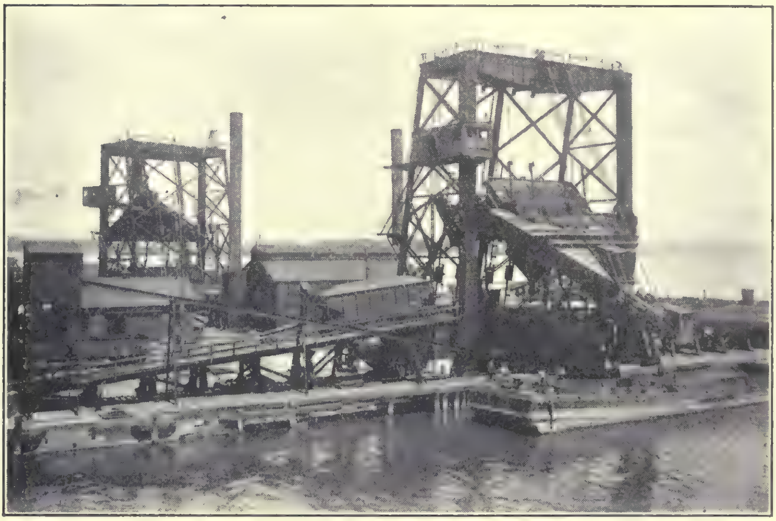

Fig. 85.—McMyler coal car dumper at Hoboken.

Beginning at the land end, the installation consists of a hump classification and car storage yard, a thawing house with a temperature of 180° which will thaw a frozen car in 30 minutes, and then two car dumpers of the familiar McMyler type. Each car dumper will handle forty 100-ton[1] or fifty 50-ton cars per hour. From the storage yard the cars roll down to the barney pit by gravity. The car is then engaged by the barney and drawn up the incline to the platen or dumper platform where it is clamped to the cradle. It is then raised and turned over through 160 degrees, dumping the coal into a pan. The empty car is revolved back to its normal position, loosened, is pushed off by the next car coming up and runs down an incline to the kick back which sends it by gravity to the empty yard. The pan containing the coal is lowered when it has received its full capacity of 120 tons. From an angle of 50 degrees the coal slides, *but does not drop, as this would break the coal,* into a hopper which feeds the coal to belt conveyors. Each hopper feeds three belts through three separate feeders. Two of these belts go directly to the pier. One goes to two balancing and two trimming bins with 1,500 tons and 1,000 tons capacity, giving a total capacity of 5,000 tons for this reservoir. This balancing bin is an excellent example of the reservoir principle. It is to take up the slack in the intermittent movement of cars and the loading process Hoppers from the car dump, and 48-inch and 60-inch belt conveyors, from the trimming and the balancing bins run out onto the pier to the loading towers. By means of a system of elevating, lowering, and trimming belts coal is uniformly stowed without at any time dropping and breaking it.

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[1] In case of ore, there are not many cars carrying 100 tons of coal.

There are four loading towers and two trimming cranes on the pier to load two large colliers simultaneously, that is, two complete units throughout. The point to be reiterated is that by means of belts and bucket "loweraters" a continuous motion has been accomplished, insured by the balancing bins which take up any unevenness. The capacity attained is astounding. At a normal operating capacity the old trestle, working 75 men, could load a 7,000-ton vessel in 7½ hours. With 12 men the new pier operating only one unit (half pier) will do the same work in 3 to 3½ hours. With only one unit of the pier in operation it has happened on several occasions that 165 cars arrived at the same time as a vessel. In eight hours they had been unloaded and assembled in trains, and were on their way back to the mines for more coal. The actual loading and bunkering of the vessel with the contents of 165 fifty-ton carloads of coal required less than four hours.

Bulk Storage.—The need of reservoirs for bulk commodities, in particular for coal, to tide over any interruption in the usual course of transportation has been brutally brought to the attention of the people of the country, especially of New York, during the winter of 1917–18. The coal situation is an acute manifestation of the necessity of reservoirs in the movement of all commodities. The lack of this provision is one of the prime causes of freight congestion and car shortage. The country has been accustomed to live from hand to mouth in transportation matters. When the railroads brought more to the seaboard than the ships could take away, having no warehouse provision to stabilize it, the transportation of the country was upset. There were no buffers, no springs, no flywheel to take up the thrust of the irregularity. When the cold days came and the coal cars did not move as usual, with the blocking of cars for the lack of warehouses to hold other commodities, there ceased to be the regular stream of coal moving to the city. There is no stored-up energy of supply which would carry the city over the dead center of traffic disturbances. The transportation system has been run on the principle of a one-cylinder motor without a flywheel. As long as it has full gas it sputters along, but let it miss fire a time or two and it stops dead.

The Stock Pile a Bulk Warehouse.—The stock pile serves as the warehouse reservoir for bulk materials. Coal, ore, gravel, sand, broken stone, and some other materials come onto stock piles for storage. The most important commodity is coal and then comes ore. All other materials are decidedly secondary in importance. Back of an ore or coal loading trestle pier is track room for the storage of cars and often a stock pile At the point of unloading from boat to land is a stock pile. Car storage is not often found as an essential part of an unloading layout, although in loading trestles car storage is most important.

In the movement from mine to boat on the Lakes, because navigation is closed for such a long time, the reservoir in the upland back of the loading piers must be exceptionally large. Sometimes as much as 4,000,000 tons of ore must be held there before the opening of navigation. This would require 40,000 cars. Much of it is held in cars, but obviously car storage will not do for the entire amount. The stock piles in the upland behind the pier must be the main reservoir in addition to many miles of railway yards. The entire problem of car dumping, piling, and retrieving has developed much invention. As a rule it is the best policy to have the largest reservoir at the mine and keep the cars moving the material to the loading pier when navigation opens.

The Rhine Harbor of Duisburg—Rührort is an example of a one-way port for shipping coal which comes from the mines in railroad cars. There are 8½ miles of basins, 96 miles of storage tracks besides stock piles to act as reservoirs. There are four coal shutes and 29 car dumpers (much smaller cars than ours).[1] Out of a total port movement in 1913[2] of 24,640,000 metric tons, 15,000,000 were from railroad to boat and only 2,600,000 tons from boat to railroad. The latter was chiefly ore from Rotterdam, for which there are two "fast plants."

The usual unloading movement of bulk materials is from the steamer to the stock pile of a steel mill or large power plant. The steel mills are the greatest consumers of bulk materials and must be absolutely assured of their supply of ore and coal for the period of closed navigation. Both the warehouse and the pier principle are involved, although at first it may seem that the pier has been eliminated. In the case of the first illustration (Fig. 82 above), of the Brownhoist ore-handling bridge crane of the Wickwire Steel Co., Buffalo, N. Y., the two movements are more distinct because the bridge tramway serves the warehouse stockpile, and the Hulett "Grasshopper" unloader plays the rôle of the pier shed and crane on the wharf front. Whether the movement from steamer to stock pile be over one bridge or over an unloader and a bridge, it is still quite necessary, in the interest of speed in unloading, to get the ore out onto the nearest spot as fast as possible. Therefore just back of the waterfront there is a small transit pile which accommodates the cargo of one or two boats. It is then necessary to rehandle this material in removing it to a large stock pile farther back where it remains until recovered for use in the plant. The second pile is the warehouse and the first the transit wharf. There is no getting away from this double handling of the major part of the cargoes unloaded during the period of open navigation.

A pair of bridge tramway stock pile and unloading cranes with cantilever drop boom extension spanning the vessel is illustrated by the McMyler installation at Port Colbeus, Canada, at the Union Furnace Co. (Fig. 86). The five-ton buckets operate in one-minute cycles and unload 250 tons each per hour. Another typical layout is the Brownhoist pair of bridges (Fig. 87). The span is about 400 feet with five-ton buckets, of 350 tons capacity per hour for each unit.

Another example of the application of continuous motion in bulk-freight handling is shown in the Stuart System of Ground

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[1] *Proceedings* of the Barge Canal Terminal Commission.

[2] *Statistisches Jahrbuch für*, 1914.

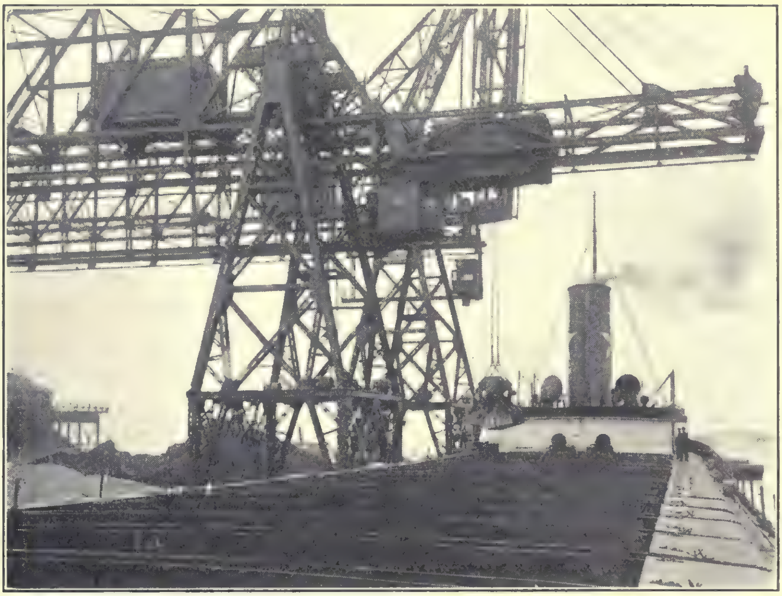

FIG. 86.—McMyler installation at Port Colborn, Ga., for the Union Furnace Co. Two tons per bucket. One minute per cycle. 250 tons per hour.

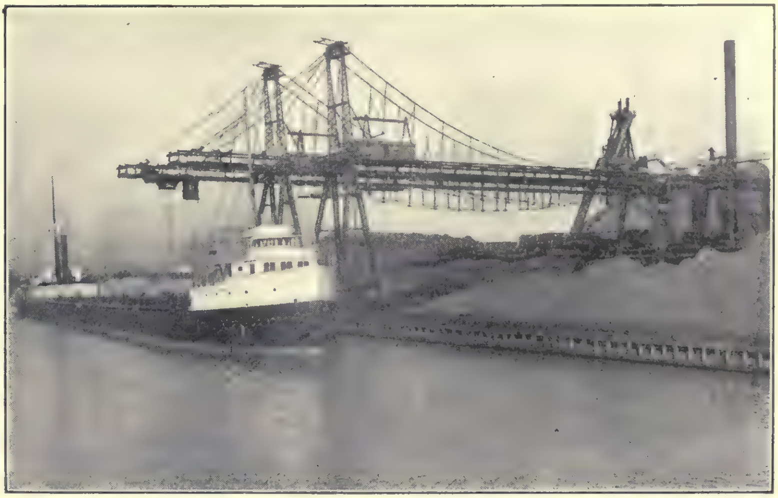

FIG. 87.—Brownhoist installation. Each bucket holds 5 tons, and can handle 350 tons per hour.

Storage and Reclaiming by means of belt conveyors. It works on the same general principle as the coal export pier at Baltimore described above.

"In the past there have been no storage and reclaiming methods that have been adequate in volume, and at the same time sufficiently economical in both installation and operation, to be generally used. Nearly all of such schemes have been some adaptation of the overhead bin or grab bucket crane.

"The Stuart System of Ground Storage and Reclaiming, as described in this Bulletin, lends itself to any capacity up to 50,000 tons, and presents an extremely low cost per ton for both installation and operation, making it commercially adaptable for mines, railroads, and industrial plants. The size, location, and arrangement can be made to conform with ordinary conditions and locations, and the capacity made as large as desired.

"To place the economical advantages of such a method within the reach of a great number of users, a few of the many possible installations of the Stuart System of Ground Storage and Reclaiming are described and illustrated in this Bulletin.

"Fig. 88 shows the system as applied to mining. It will be seen that material received from the tipple or discharge point of mine cars is fed automatically to a conveyor which carries it to the stacking or loading machines, to be loaded direct into the cars when they are available, or, in the event of the cars not being available, placed into the storage piles alongside the track, to be reclaimed at some future time. This provides a balancing unit or reservoir between the mine and car supply, removing the present uncertain and disorganizing effect of a mine operation which is dependent upon a daily car supply, and establishes the possibility of a continuous mine operation.

"The storage pile for economy is placed on the ground and may provide for several days' or several weeks' output of coal at the mine so that all employees can be assigned to regular employment each day, irrespective of the supply of cars. This reclaiming device is so arranged that when cars arrive, regardless of the hour, the reclaimer draws upon the storage pile and by use of the stacker, moved to the car yard, loads material into cars at a rapid rate.

"Another feature in connection with this method of storage is the providing of an electric weighing apparatus by which the material in motion is weighed and a record of the tonnage made. If desired, by setting a limiting device, a predetermined tonnage or charge may be delivered, at the completion of which the loading automatically ceases and the limit stop may be reset for a new tonnage, thus securing a correct car tonnage record and, in the case of loading box cars, a proper distribution of load over the trucks. There is also a register which

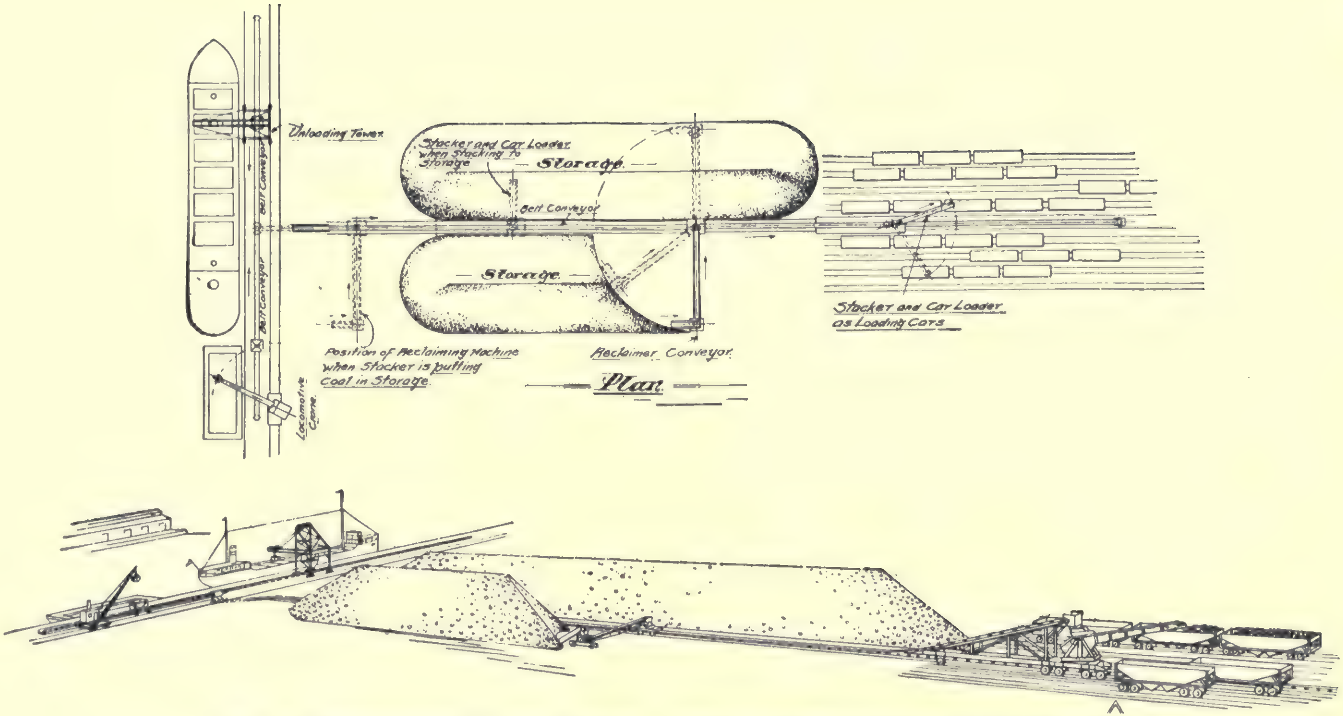
Unloading Tower
Belt Conveyor
Belt Conveyor
Locomotive Crane
Stacker and Car Loader when Stacking to Storage
Storage
Belt Conveyor
Storage
Position of Reclaiming Machine when Stacker is putting Coal in Storage
Reclaimer Conveyor
Plan
Stacker and Car Loader as Loading Cars

FIG. 88.—Stuart system of ground storage. Lateral movement by means of belt conveyors.

makes a record of the total tonnage handled over the loading machine. This weighing apparatus in all its functions is guaranteed for accuracy within one-half of one per cent.

"Fig. 88 shows an adaptation of the Stuart System of Ground Storage and Reclaiming as applied at the terminal where material is delivered by barge or vessel. It will be seen that material received on barges or vessels may be unloaded by gantry, locomotive crane, or any of the well known methods of unloading, the material being delivered to a traveling hopper which automatically feeds it to a conveyor running parallel with the side of the "dock." This conveyor carries the material and delivers it to another conveyor running parallel with or between two storage piles, into which it is loaded and afterwards reclaimed for loading to cars or other carriers.

"By this adaptation a balancing unit or reservoir is provided between the water carrier and rail or other means of despatch. This same operation may be reversed, allowing the system to serve as a balancing reservoir between railroad cars and water carriers.

"The location of the storage may be at right angles to or parallel with the pier or dock, depending on local conditions.

"In present practice, there is a loss of efficiency in coördinating supplies of material between vessels and cars. Material after loading is held in cars or vessels until either vessels or cars are available.

"If a vessel is available, the material, in any event, is held in cars at terminals or along the line until the full cargo is at hand. In the case where the material is received from vessel, the vessel is held until the cars are available, when the present slow and expensive process of discharging from boat to cars is begun."[1]

Stock Pile Foundations.—The technical difficulties of the stock pile are greater than they would seem at first. An example of the problems involved, from the engineering point of view, may be gleaned from abulletin of the Cleveland Dock Engineering Company. The stock-pile floor in point was built for the Detroit Iron and Steel Company, and is of particular interest because the plant and the stock pile are built on reclaimed marsh land. The pile is built "on a wet sponge." The utilization of marshy land for industrial purposes is of much interest because the future of scientific harbor building in the United States will have to do with reclaimed land. Reclaimed marsh lands usually is the only land properly located for municipal harbor works which does not require a prohibitive amount of expropriation of existing owners.

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[1] *Bulletin* No. 3 of the International Conveyor Corporation.

The wharf in question consists of two parts, the wharf apron and the stock pile floor (Fig. 89).

The site of the proposed wharf and pile (they call it an ore "dock" on the Lakes) was low-lying marsh, often half a foot to two feet under water. The problem was to build a platform on this sponge which would carry a load of 7,000 lbs. per square foot, put upon it by the mountains of ore. The ore floor, 173 feet deep, is a reinforced concrete mat a foot thick, resting on piles driven five feet on centers in both directions. Connected to this floor and forming an integral part of it is the wharf

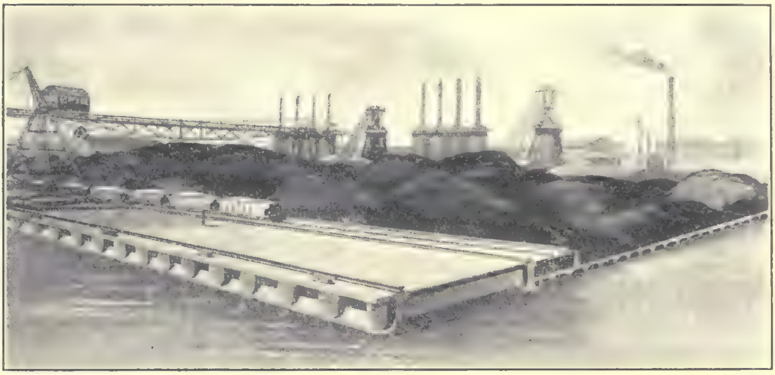

Fig. 89.—A perspective showing clearly the arrangement of dock girders and ore floor in the Cleveland dock built for the Detroit Iron and Steel Company.

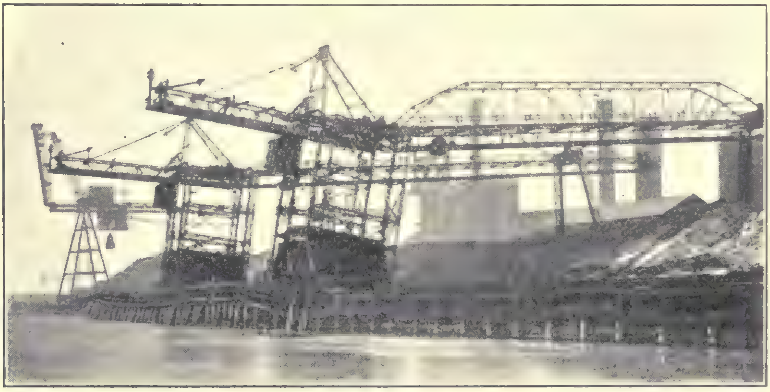

Fig. 90.—This shows the way the timber docks fail. The weight of the ore forces them outward and upward.

apron extending over the water to deep water. This consists of two massive reinforced concrete longitudinal girders, nine feet high, the bottom flanges being five feet wide and the webs 16 inches thick. The top flange of the outward girder is extended outward as a 10-inch bracketed shelf, shoreward as a six-inch floor to the other girder. Supporting this floor and tying the girder together are concrete beams, 10 feet on centers, 10 inches thick and five feet deep. By giving the stock pile full support the tendency to force the mud out from under the load and upwards at the wharf edge, thus completely deforming the wharf front and unloading bridges, has been eliminated (Fig. 90). There have been conspicuous failures of unloading wharves where the stability of the bearing surface of the stock pile was not provided for.[1] The illustration serves to show that, by building properly, many acres of marsh land at present valueless may be made into the most desirable industrial harbor areas.

Ship Bunkering.—The discussion of coal and bulk freight handling would not be complete without brief mention of the very important process of ship bunkering. It is assumed that in a well regulated port the coal harbor is a roomy and well equipped institution. Such a coal harbor will always have the economic advantage because in concentrating all the available coal traffic at one point it is possible to install the best available equipment and yet have the per ton expense of loading, and unloading, reduced to a minimum. The coal harbor of a port would have fast plants for unloading, the most improved loading machinery, and the necessary upland for car storage and classification yards.

But make this coal harbor as complete as it can be, and even then ships will not bunker there. Ships will go to the coal harbor to get cargo coal but not bunker coal. A coal ship would bunker there not because it is a coal harbor, but because the coal harbor would happen to be the ship's berth while in port loading or discharging cargo coal. Invariably bunker coal will be brought to the ship and not the ship to the coal pockets. A ship in port has no time to shift its berth unless it be from a discharging to a loading berth. Therefore the coal lighter, with bunkering machinery if possible, but always the coal lighter, will come to the ship.

In the Carribean, at Bridgetown and elsewhere ships are coaled by native women who carry small trays of coal on their heads. In many ports the coal is brought alongside in lighters and shoveled into buckets which are raised by the ship's tackle and dumped into the chute to the bunkers. The bucket and shovel system is slow and wearisome. Even if it be possible to bunker a ship by this means during the time she is discharging and loading, it is expensive. As ships grow larger and faster, consume more coal and yet stay a shorter time in port, something must be done to speed up bunkering. There have been many ingenious developments.

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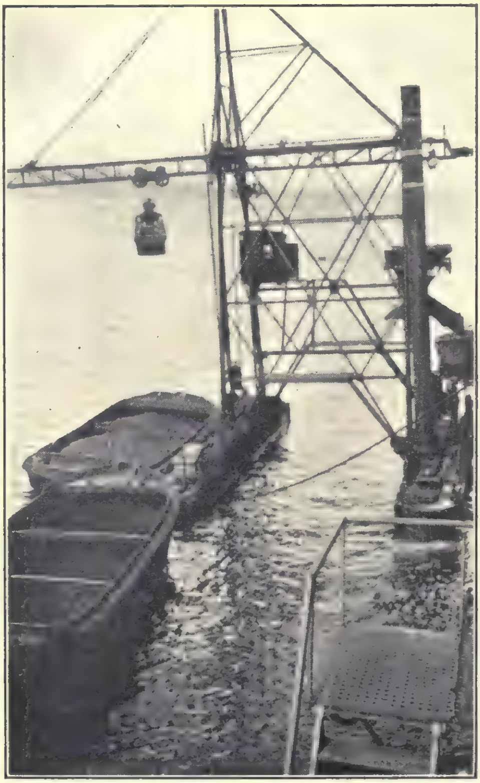
[1] *Bulletin* No. 1 of the Cleveland Dock Engineering Co.



(Photo by author)

FIG. 91.—A Catamaran steam bunkering equipment at Bergen, Norway. Traveling grab-bucket discharge into hopper feeding ship's bunkers.

At Bergen, Norway, I watched an excellent floating bunker machine. It consisted of a tower carrying a bridge crane of the tramway and grab bucket type, as in a fast plant. The track, which was quite high to accommodate large ships, consisted of the bridge span and the two projecting booms. The interesting feature was the foundation of the legs of the bridge on two separate floats, catamaran style. These spread legs enabled the coal lighters to set either between the legs or outside the outer leg. By having two berths for the lighters, no time was ever lost in shifting an empty for a loaded lighter. The clam-shell bucket was of the familiar type and it discharged into a hopper which fed the coal into the bunkers. One man in the tower operated the entire machine except for shifting the barges and a little trimming. This seemed to be a truly efficient bunkering system (Fig. 91).

A recent development of the continuous-motion principle in bunkering is the De Mayo portable elevator. The machine consists of a bucket belt in a casing containing the motor which drives the belt within the casing, thus making the machine self contained. The lower end allows the buckets to bite into the load of coal. The entire machine is suspended from a boom and allowed to sink into the coal by its own weight. The coal is elevated by the buckets on the chain and discharges into a flexible spout which feeds it into the ship's bunkers.

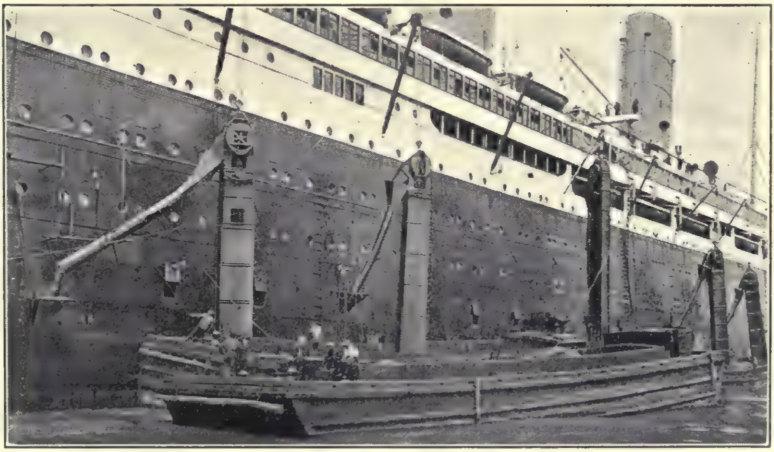


Fig. 92.—De Mayo portable elevator for bunkering coal.

The capacity may be increased by increasing the number of the units. This gives great flexibility in the use of a bunkering equipment. A ship bunkering at the pier is eased off from the pier with booms far enough to allow coal barges to come along the pier side as well as the ship side. The De Mayo Company states that frequently they have put 8,500 tons of coal into a large vessel in 21 hours, using ten machines. On one occasion the firm bunkered the "Imperator" with 8,200 tons of coal in 19 hours.

These two examples, one in Norway and one in New York, serve to illustrate the possibilities and the nature of mechanical coal bunkering.

Grain.—The storage and loading of grain were among the first operations to be handled by a continuous motion system. Belt conveyors and pneumatic suction elevators have been in use for many years. The details of this machinery may be shown in a few examples below. Here the movements and principles only need to be considered.

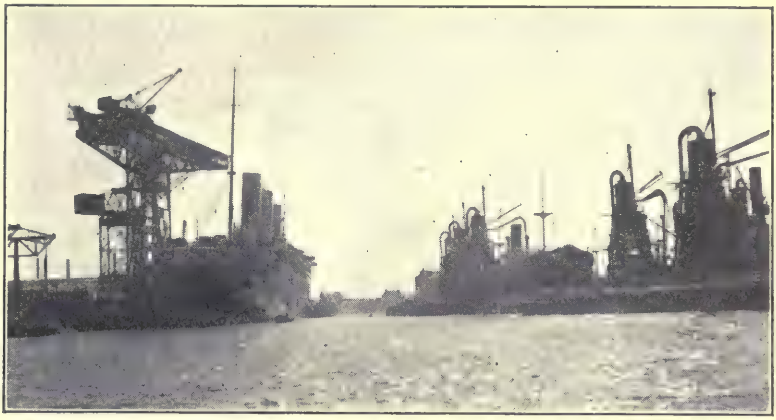
In the United States the grain movement is for export, in Europe it is for import. In the United States the grain arrives from the fields largely in railroad cars and to a small extent by canal barges for loading into ocean-going vessels. In Europe it arrives in ocean-going vessels to be transshipped largely into barges and to a small extent into cars destined for the interior. Transshipment from barge to ship will grow in the United States as the waterways come into their own as transportation lines for bulk cargo. In time we should develop at New York and at New Orleans transshipping points for grain as efficient as those of Hamburg, Rotterdam, and Antwerp.

Direct transshipment from barge to ship or vice versâ by means of powerful pneumatic elevators is the most economical movement for several reasons. (1) The movement of the cargo grain from and to the interior by means of large capacity barges is more economical than by rail. (2) When barges are used, in particular tow barges not made more expensive by propulsion machinery, the expense of holding the barge for several days as a warehouse for the grain is not excessive. To a large extent this saves the additional expense of temporarily storing the grain in elevators pending shipment. If this storage is not too long reconditioning in an elevator is not necessary. (3) The cost of loading overside by means of pneumatic elevators is low as the distance of travel of the cargo is short. In the case of tramps loading in stream, with free mooring-post wharfage, the item of wharfage and lighterage would be saved. Four floating elevators working from both sides can transfer 3,000 tons (112,000 bushels) of grain from barge to ship in a nine-hour day.

In the main the grain carriers are liners, taking on other cargo and passengers at piers. The loading is therefore only possible from the water side. However, the economy of bringing the grain barge alongside the liner and transshipping from barge to ship is obvious. The operations of "warehousing" the grain in an elevator and then lightering to the steamer are saved by the barge-to-ship movement. The movement is somewhat analogous to the freight car-shipside movement, but even better than this, as no expensive transit shed is required. In the case of general cargo the freight car may be brought alongside the shed opposite the ship, but the freight must be piled in the pier shed ready to be loaded into the hold in a rapid and orderly manner. In the case of barge-ship transfer of grain this movement is also eliminated and the ideal of all freight movement is accomplished, which is from the source in the interior to alongside the ocean steamer without breaking bulk and rehandling.

The first requirement is that there be ample barge harbors where the barge may be held at moorings until the ship is ready for the cargo. This may be several days or a week. At Hamburg the Moldau Harbor of 70 acres is built and operated as this kind of a terminal. That is, there are warehouses and sheds and other terminal facilities especially for barge traffic in general, and in addition, a large water area to accommodate barges waiting for the ship. The economy of this system of short term storage on the barge to save rehandling of the grain is a cogent argument in favor of tows and not self-propelled barges for this class of freight. If not unnecessarily expensive the barge acts most efficiently as its own pier shed. However, this rule of tow vs. self-propulsion does not apply to package freight, where oil motors and power plants are the ideal equipment.

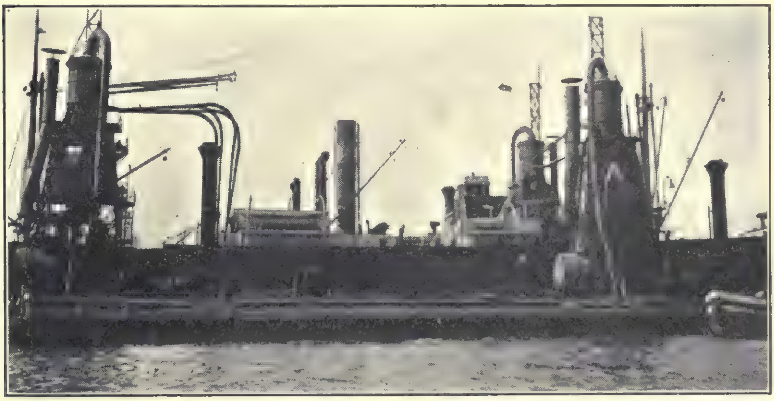
Direct barge-ship loading is possible for only a part of the grain during part of the year. The grain warehouse or elevator to act as a reservoir still remains a most necessary factor. During the short period of open navigation on the Lakes and the Barge Canal or other waterways, which comes between the harvest and freezing time, the largest part of the grain must be moved to the seaboard or some intermediate reservoir such as Buffalo. To retain the golden flood in order that it may flow regularly and freely during the remainder of the year is the great grain elevator problem which has called into action so much engineering talent.



(Photo by author)

FIG. 93.—A basin at Hamburg with grain elevators discharging from a steamer to barges, on the left, under the crane, the "Leviathan" at the fitting out quay being finished.

Ocean steamers may be loaded directly from the grain elevator. Again there must be no illusions. In the case of a liner carrying the grain abroad she can not go to the elevator. The grain must be brought from the elevator to the ship in lighters and elevated aboard by floating pneumatics.



(Photo by author)

FIG. 94.—In stream transfer. A grain ship at mooring-posts discharging into an Elbe barge of 500–1000 tons capacity. Four pneumatic elevators will transfer 112,000 bushels in 9 hours.

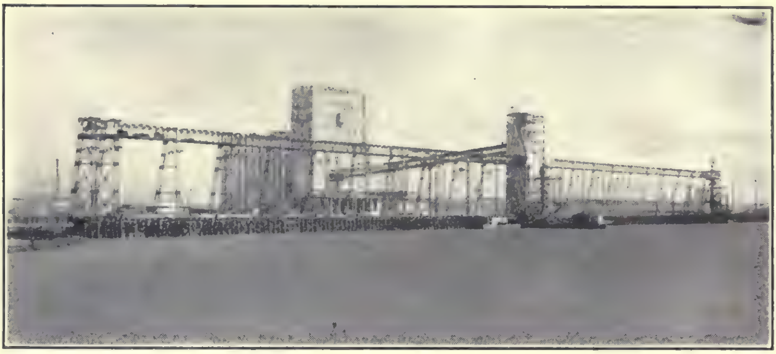
One of the first great Continental ports that tried to use the pneumatic elevator was Antwerp. However, organized labor prevented its use. Rotterdam then decided to use the efficient modern methods, and set aside a fighting fund of 400,000 guilders ($1,000,000) with which the stevedores were finally beaten. The grain center moved to Rotterdam where it has remained ever since, with little chance that Antwerp will regain it, although modern equipment finally was installed there too.

Grain Piers.—The pier is a more economical form of landing than the wharf parallel to the waterfront in handling grain. As there is no transit storage requiring a pier shed in the case of grain, the pier may be long and only wide enough to carry the machinery for handling, consisting of belt conveyors and elevating and lowering spouts, which require very little width. The pier may be as long as the longest vessel using the facilities. The movement is in a straight line from the pier across the marginal street to the storage elevators at the upland.

In fact, at Bremen, where the quay system has been followed in the other portions of the harbor, the grain-handling section was built with a series of piers. These piers handle grain between ships, barges, lighters, railroad cars, and elevators. Transfer from ship to canal barge, at Bremen, is made not in midstream, but over a transfer pier by means of pneumatic transfer elevators which move along the pier to points opposite the hatches as any other crane would do.

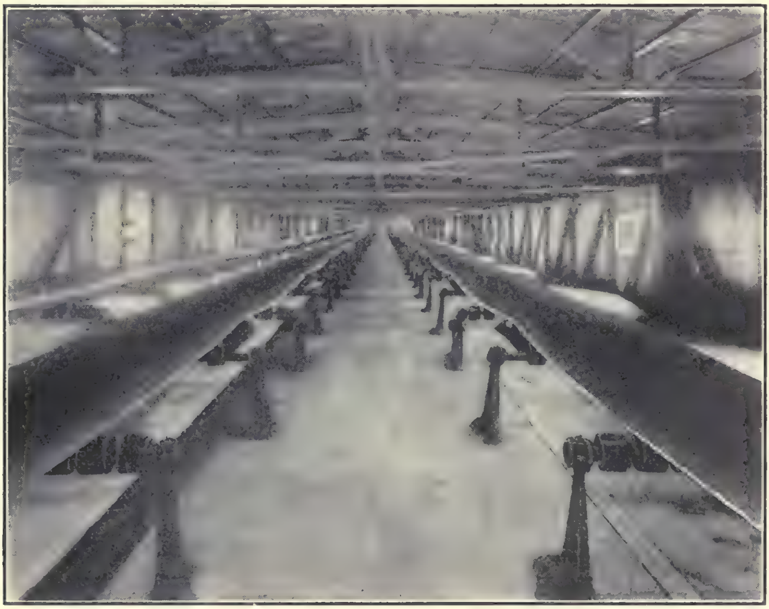
The Grain Elevator, among many other differences from the ordinary goods warehouse, must be closely connected with the wharf. We have seen that the usual goods warehouse may be situated back of the wharf shed or may be in a group of warehouses in another part of the harbor. Not so with the grain elevator. The conveyor belt from silos to suction and feed spouts in the hold of the vessel must be as short as possible. Valuable waterfront property need not be occupied by the elevator down to the water's edge. The additional expense of carrying the conveyors across the marginal street to the elevator on the inland side of a marginal street is in no measure commensurate with the value of the street and the bulkhead line for the commercial use of the public.

The last word in grain-handling is the municipal elevator at New Orleans. The description of this great enterprise as given by the engineers (Ford, Bacon and Davis) will sum up the essentials for this class of harbor equipment.



(Courtesy Ford, Bacon and Davis)

Fig. 95.—Public grain elevators at New Orleans. General waterfront view, showing loading wharves and conveyor trestles.

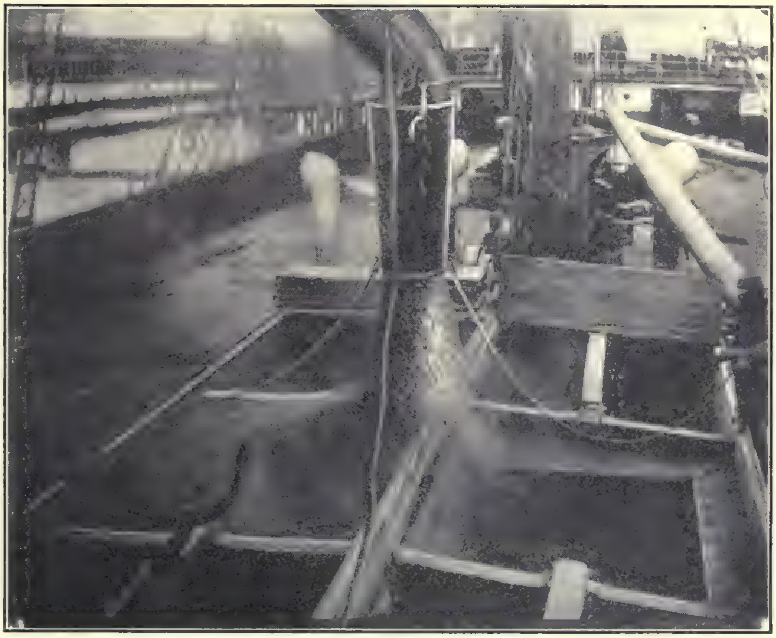


(Courtesy Ford, Bacon and Davis)

Fig. 96.—Public grain elevators at New Orleans. Conveyor gallery and belts.

"The Public Grain Elevator and Terminal at the Port of New Orleans is owned and operated by the Board of Commissioners of the Port of New Orleans. The plans for the elevator were made after thorough investigation and consideration of modern grain elevators in the United States, Argentina, and Canada, and the completed plant probably includes advantages over any other elevator now in service in:

1. Rapid handling and relatively large receiving and shipping capacity.
2. Great flexibility in the conveying, distribution, and grain-blending systems.
3. Loading, unloading, and transportation appliances as described."



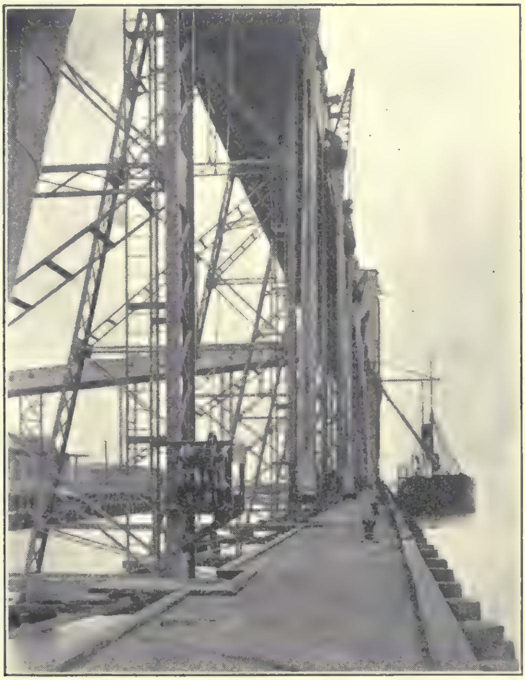
(Courtesy Ford, Bacon and Davis)

Fig. 97.—Public grain elevator at New Orleans. Loading a ship from spouts.

This elevator is described here at this point as an illustration of a modern elevator equipment as a municipal enterprise. There are many other worthy examples which might be mentioned if space permitted. For instance the new Washburn, Crosby & Co.'s grain elevator at Buffalo has a capacity for 4,000,000 bushels of grain. There are 18 elevators at Buffalo alone.

Description.—"The grain elevator is located on the east bank of the Mississippi River at the head of Bellecastle Street on the Public Belt Railroad, adjacent to and directly west of the new public cotton warehouses and terminals.

"This improvement may be classed as the second most important public commercial enterprise in New Orleans, and, as a factor in carrying the port's facilities to the highest state of efficiency, ranks next in value to the state owned and operated cotton warehouses. As the great cotton trade of New Orleans demanded the cotton warehouses, so the rapidly increasing grain export business of the city made imperative the erection of the grain elevator.



(Courtesy Ford, Bacon and Davis)

Fig. 98.—Public grain elevator at New Orleans. Loading trestle and wharf.

"The main plant comprises a track shed, drip shed, workhouse, storage annex, drier house, shipping conveyor gallery, dock gallery, and marine tower. All buildings are of reinforced concrete, the galleries and marine tower are structural steel with book tile roof and floor. The entire plant is fireproof. The structures are supported on long leaf yellow pine piling, jetting in place, cut off well below the water line and capped with concrete.

Track Shed, Drip Shed, and Unloading Tracks.—"The track shed is 80 × 156 feet, with a clear height of 23 feet from the head of the rails to the beams. Under the shed are installed four unloading tracks, under which and at right angles are the two conveyor belts carrying grain from the sinks to the receiving legs of the elevator. Each belt is supplied by a battery of four independent receiving pits, each having a capacity of 2,000 bushels, so equipped with interlocking mechanism and signals as to make it impossible to mix the contents of the different cars.

"A four-drum elcetric car haul is located at the east end of the track shed. Each drum is capable of handling a full train of loaded cars. The tracks in the shed are built on a grade running from the track shed east, so that as the cars are emptied they will move down this grade by gravity into the receiving yard for empties.

Workhouse.—"The workhouse into which the grain is delivered from the receiving pits is 47 × 117 feet and is located north of the track shed and separated from the track shed by a distance of 45 feet. The workhouse is 208 feet 6 inches high above the pile cutoff and contains 47 bins, ranging in capacity from 2,600 to 5,000 bushels, which have a combined capacity of 175,000 bushels. In the workhouse, on the south side, are located the two receiving legs equipped with 40-inch elevator belts, on which there are two rows of 18 in. × 8 in. × 8 in. elevator buckets. These receiving legs take the grain from the transfer belts and elevate it to the top of the workhouse where it is discharged into the 3,000-bushel concrete garners.

"On the north side of the workhouse are the four shipping legs, which are the same size as the receiving legs; each of the legs has a capacity of 2,500 bushels per hour. The drier and general utility leg, with a capacity of 10,000 bushels per hour, is also located on the north side of the workhouse.

"In the basement of the workhouse is located a 40-inch reversible transverse conveyor belt with a capacity of 25,000 bushels per hour. This belt receives grain from the workhouse storage bins, cleaners, clippers, and drier, and delivers it to all legs, both shipping and receiving.

"On the first floor of the workhouse are the cleaning machines and oat clippers, which are so arranged as to allow the grain to be discharged directly into the machines from the bins of the workhouse and in turn spouted direct from the cleaning machines to three different elevator legs, each, and transverse conveyor belt in the basement.

"In the cupola of the workhouse there are two transverse conveyors, which receive the grain from the hopper scales. This feature, by which the grain is delivered direct from the scale onto the transverse conveyors and onto the storage conveyors, or directly into the bins of the workhouse, is novel and one which greatly increases the flexibility and rapidity of handling grain through the workhouse. There are seven hopper scales, each of 2,000-bushel spouted capacity, equipped with a weight-lifting device. On the top floor of the workhouse are the leg heads, and immediately below is the general machinery floor where all of the electric motors for driving the legs are installed.

Storage Annex.—"The storage annex is located on the north side of the workhouse and consists of 60 circular tanks and 45 interstices. The capacity of the tanks is 12,100 bushels each and of the interstices 2,690 bushels each.

"There are several special features embodied in the design of the basement, which is provided with head room of 17 feet 6 inches from the bottom of the bins to the basement floors. The basement is entirely open, affording ample light and ventilation, while the head room permits the use of turn-heads under the storage bins, giving delivery from 48 bins on any one of the four shipping conveyors. The second special feature of design is the bin floor and cupola. Above the bin floor of the annex is the installation of Mayo spouts and storage belts, which forms the most complete distributing system to storage yet installed in this type of elevator. The great flexibility of the system is shown when it is stated that the center belt is capable of delivering grain through the Mayo spouts to 105 bins.

Shipping Conveyor.—"The shipping conveyor gallery leaves the south side of the warehouse just below the four shipping bins at an elevation of approximately 60 feet above ground level and extends out to the dock gallery a distance of 400 feet, at a grade of approximately 10%.

"In the shipping conveyor gallery are four 40-inch shipping belts which discharge into hoppers in the marine tower, which in turn discharge onto the 40-inch belts in the dock gallery. The dock gallery extends 650 feet parallel to the wharf, both east and west from the marine tower, a total of 1,300 feet. The capacity of the four shipping conveyors is 100,000 bushels per hour, all of which may be used to load from one to four vessels at the same time.

"Along the dock gallery a system of spouts 60 feet on centers is provided for both "First" and "Second Off" loading. The conveyors in the dock gallery are so arranged that either one or both can be used for either "First" or "Second Off" loading.

Marine Tower and Pneumatic Unloader.—"On account of the large amount of grain accessible to the Mississippi River, and the desirability of bagging grain at the dock front and to accommodate more readily the variation in water level and the varying dimensions of barges and vessels, a marine tower equipped with a pneumatic unloader and ample storage capacity is located in the center of the dock gallery at the point where the shipping conveyor gallery joins the dock gallery. The grain when lifted from vessel or barge is discharged into hoppers located at the top of the marine tower, and from these hoppers to one of the 40-inch shipping belts, all of which are arranged for reversible operation.

Drier House.—"The drier house is located on the east of the workhouse and contains two driers each with a capacity of 1,000 bushels per hour. The building provides storage capacity above the drier for a full day's run, which can be filled in less than half an hour from three different parts of the storage. The building also provides deposit for a half day's run below the drier.

Bagging Grain.—"Provisions have been made for bagging grain in the marine tower and in the elevator. In the former the bagging platform is located about 15 feet above the wharf, where the grain is weighed into bags by automatic scales. Similar provisions are made on the first floor of the workhouse where the bagging platforms are located.

Dust-Collecting System.—"The dust-collecting system is a most efficient installation of its kind, insuring cleanliness and freedom from dust explosions. There is in this elevator small possibility of dust accumulation, and with reinforced concrete construction throughout the structure the lowest insurance rates are obtainable.

Present Operation.—"As mentioned before, the shipping capacity of this elevator is greater than that of any similar elevator at any Gulf or Atlantic port in this country, which should render the plant particularly attractive to ocean vessels, due to a minimum loading time necessary. The elevator has been in operation since February 1st, 1916, and has up to July 16th, 1916 received 5,341,933 bushels and shipped 4,275,392 bushels. For the month of June, 1,600,071 bushels were received and 1,340,533 shipped."

CHAPTER XV

INLAND WATERWAYS AND THE SEAPORT

For some years the legislators and business men of the United States have been particularly interested in waterway development. Much mud has been slung at inland waterways by those who have had a suspicion that inland navigation in the United States has been prompted by an interest in government expenditures in particular districts. This feeling that inland waterways and the improvement of water transportation was a "pork-barrel" measure has been most unfortunate and has cast a decided gloom over any plans for improvement.

Doubtless there has been considerable justification for this criticism in the expenditure of billions by the National Government in the past. Doubtless there are many creeks and canals which run from nowhere to nowhere else, which have been dredged to accommodate 1,000 ton barges with no opportunity whatsoever of bringing such barges into this waterway except to build them along its shores. Expenditures in the past have been under the curse of sectionalism. What has already been expended, if it had been controlled by a great central commission of disinterested economists and engineers and directed towards national ends, would have put the waterways of the United States upon a high plane of inland navigation.

As in many other spheres of activity, we are forced to look to Europe for examples of inland waterway development. Outstanding examples of the influence of water connection with the interior upon the growth of the seaport may be noted. Manchester immediately comes to the mind. In the case of Manchester we have an inland city which decided no longer to be an inland city and built a canal to connect it with the Seven Seas. In fact, the Manchester Canal brings commerce around the ancient and well-established port of Liverpool directly to the doors of the manufacturers located in Manchester. This effort on the part of Manchester has been singularly successful and

Manchester has grown to be not only one of the great manufacturing centers of England, but also one of the greatest seaports.

The ports, in the history of commerce, which have been outstanding as of world importance have been situated either "at the entry to the sea" as was Tyre, or on an inland waterway connecting the interior with the sea. Among these great inland seaports are Bordeaux, Cologne, Rouen, and later Amsterdam, Antwerp, London, and Hamburg. Each is situated at the point where it is most convenient to transship from river barge to ocean ship—to effect the juncture between the inland carrier and the sea carrier. Although Bremen in the 12th, 13th, and 14th centuries was the leading city of the Hanseatic League, the modern port of greatest importance on the North Sea has been Hamburg on the great river Elbe and not Bremen on the little river Weser, because Hamburg had its connection with an interior extending even into Bohemia. Rotterdam, after completing connecting lines with the many mouths of the river Rhine, has grown by leaps and bounds to be one of the first ports of the world, because of the traffic on inland waterways.

Turning again to the United States, we find the greatest example of the influence of water connection with the interior upon the growth of the seaport city at New York. As with the European ports just mentioned, so at New York nature was not sufficiently lavish in offering a water high road for commerce. It was necessary for merchants and governments to improve these waterways and make them equal to the demand put upon them. As these waterways came to be successful tools of commerce, in the same measure the cities along their banks and the ports at their mouths became great.

The Erie Canal opened the entire Great Lakes region, as well as up-state New York, to the sea.

In like manner the Mississippi Valley developed the cities of St. Louis and New Orleans, and the Mississippi steamboat described to us so vividly by Mark Twain carried western civilization into the wilderness of the interior of the great American continent.

Then followed the era of the railroads and the years of intense competition which finally resulted in railroad agreement and rate structures which have been upheld for forty years until the great war. The two great systems of waterways, the Hudson-Erie-Canal-Great Lake system and the Mississippi system by themselves could not have developed the country as the railroads have done. With the rise of the railroad and its possibilities for developing these United States, and with the enormous growth of population and commerce which followed the railroad, the waterways remained at a standstill and finally relapsed into a state of innocuous desuetude.

The railroads were hardy pioneers, reaching out into the wilderness with all hope of reward dependent upon the growth of the communities which they touched. These communities in the beginning could not possibly offer to the railroads large quantities of freight or passengers for them to carry and thus make returns on the investment. It is only natural that the railroads should have been exceedingly jealous of every particle of traffic which could be gathered out of these newly opened areas, and that they should have fought the water carriers for what freight there was to be had.

With the great war a new situation has arisen. It has become evident to all that the railroads have more to carry than they can handle. The railroad net has spread in every direction over the country. Where a few decades ago only a few lines of rails extended through rural communities, we now find a closely woven iron web connecting gigantic industries and teeming centers of population. If we take a railroad map of the world and compare Europe with the eastern part of the United States, we now find a striking similarity in the density of the rail lines. The similarity is even greater than the map will show. In the place of a few lines struggling to operate at a profit by capturing all the traffic which was to be had, we now find the railroads breaking down under the weight of traffic which comes to them. This happened in Europe (in not so acute a form) some years ago. In Europe the railroads had sufficient volume of tonnage in high-class freight or short-haul freight for them to be quite willing and anxious to allow low-class freight, such as ore and coal, to move by water whenever possible.

The changed conditions have ushered in a new era in transportation. In the beginning we had in Europe and in America the waterways as the only means of transportation. Then came the railroads, which offered a more rapid and flexible means of transportation than the waterway, but there was not sufficient traffic to maintain both, so the waterways died because they could no longer compete with the railroads in a struggle of the survival of the fittest for the scant supply of freight offered by the young country. Then came the most modern period, which was ushered in so suddenly in the United States by the collapse of our transportation system during the great war. Now the railroads can no longer move both high-class and bulk freight and the cry has gone up from all concerned to utilize the waterways to relieve the congestion of the railroads.

The new order of things was foreseen by the State of New York in 1905, when it decided to modernize the water connection between the Great Lakes and the Hudson River Valley. The estimated cost of this improvement, including terminals, is $155,000,000. This single improvement costs more than half of the sum of $305,000,000 which the State of New York has spent on waterways to September 30, 1915 (including the estimates for the new canal). The Barge Canal is not a mere enlargement of the old Erie Canal, but for 60% of its distance follows an entirely new course (Fig. 99).

A new canal was necessitated by the same principle of evolution in the water carrier which has been effective in both the land and ocean carrier, the larger the vehicle or vessel the more economical the operation. Railroad cars have increased from 10 tons to 100 tons capacity; cargo steamers from a few hundred tons to 10,000 and 12,000 tons. Economy of transportation on a barge canal to-day requires a movement of freight in vessels of 1,000 or more tons in place of the 240-ton barges of earlier times. Roughly speaking, the material entering the hull of a vessel increases in square measure while the room in the hold increases in cubic measure. The long and narrow barge is easier to tow. It offers less resistance per ton of capacity. With the installation of labor-saving machinery, particularly the huge cranes, buckets, and elevators for loading and unloading bulk material, it is more economical to load and unload a large vessel than a small one. Therefore a larger canal to carry larger vessels has become necessary.

With the growth of the size of the vessel the method of propulsion has changed. At the time of the development of waterways in Europe the most economical method of propulsion was the steam towing barge or steam tug. The introduction of the steam tow to supersede the old horse on the tow-path ushered in a new era in canal transportation. The great European systems use 500-ton to 3,000-ton barges in trains of three to six towed by a

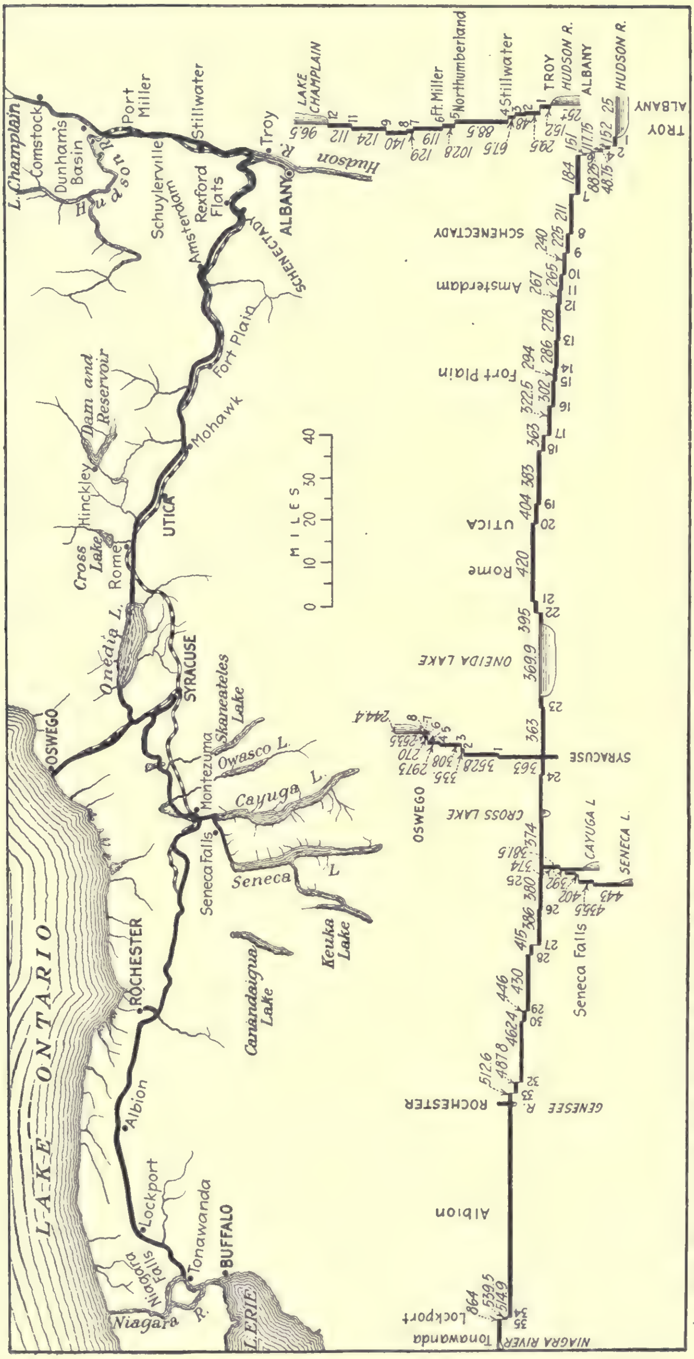


FIG. 99.—Route and Profile of the N. Y. Barge Canal and its tributary connections. Old Erie Canal is shown by a broken line.

huge steam barge which may or may not carry cargo. For small units handling package freight, it has become evident that the internal combustion engine, burning kerosene or crude oil, such as engines of the Diesel type which have been so highly developed within the last decade, may be the most economical. In rivers having frequent turns and sand bars which render navigation difficult, the self-propelled barge driven by an internal combustion engine has come to be considered the most economical form. Efforts to develop Mississippi navigation and also efforts to develop navigation on the Vistula, Volga, and other rivers in Russia, have brought about a high efficiency of the motor barge.

Not Waterways vs. Railways.—The modern inland waterway, therefore, is quite a different institution from the old pre-railroad days. Instead of being a competitor to the railroads, inland water navigation comes as a relief to railroad congestion, offering to carry large quantities of bulk materials in efficient and economical manner, leaving to the railroads freight of higher specific value.

The new inter-relation between railroad and inland waterways is one involving many problems which are now clamoring to be solved.

In the first place, how can the railroad and the waterway be brought into harmony? The first requirement is that a government institution be established which will so coördinate rail and water carriers as to make it attractive to private or public institutions to operate the waterways and at the same time will make it attractive to railroads to make short hauls in order to turn over to the waterway the bulk freight which the railroads have been trying in vain to carry. As the railroads have been making their profits from the long haul, it is natural that the idea of the short haul will be abhorrent to their traffic managers. In fact, it is only through a nation-wide adjustment of the conflicting interests between railroad and water carriers that there is any hope of getting past a certain dead center to the point where the railroads and the government will see that as time goes on the more economical method is rail *and* water movement, particularly in the case of bulk commodities.

The result will be to the advantage of the railroad and to the country at large. Any new departure in economic life causes a readjustment. However, if we are to profit from the experience of Europe we will find that teeming hives of industry situated on navigable waterways have given the railroads an undreamed-of volume of package freight to carry. It will be seen that successful river and canal ports also have become the great railroad centers. One finds at the inland port one of those peculiar cycles of the snowball type. The waterway makes it attractive and economical for industries using large quantities of raw material, particularly coal, and iron ore, to locate on its shores. The industry prospers because of the low cost of transportation of raw materials. It widens its markets because of reduced cost of production. Some of the finished products may leave these plants by river barge, but as a rule the consumer is anxious to receive prompt delivery and will gladly pay express rate or fast freight rate service on a large proportion of the valuable finished product. Therefore the railroads increase their business in high class freight from the inland ports where prosperity is founded on cheap water freights for raw materials. The excellent report of the Barge Canal Terminal Commission for 1911 will illustrate the manner in which the cycle has been demonstrated in the case of German waterways.

Also in recent numbers of *Le Génie Civil*, particularly of the 31st of May, 1917, and subsequent issues, appeared a series of articles regarding *Navigation Interieur* in which the study and adaptation of the German canal and river transportation and port systems to French conditions were urged. *Le Génie Civil* draws particular attention to Neuss and Frankfort-on-the-Main.

The River Port of Mannheim.—Perhaps an even better example of the interior or inland port and the relation of water to rail carrier may be found at Mannheim. Mannheim is the "seaport" of Bavaria and Baden. Mannheim has a hinterland for local and maritime commerce just as any seaport has. Goods transshipped directly from sea-carrier to barges, of 3,000 tons capacity, may come from Rotterdam into the port of Mannheim. Most of the freight from overseas comes through to Mannheim in bond. In Mannheim are 150 bonded warehouses; 25 of these are devoted to tobacco, 10 to grain; 23 to coffee and other colonial goods. In 1912 Mannheim paid 50,000,000 Marks or $12,000,000 in customs duties to the Empire. At the head of the list of goods received stand wheat, petroleum, tobacco, corn, and coffee. There were more than 108 important articles besides many others (Fig. 100).

The remarkable extent to which Mannheim is a link between inland navigation by water and freight movement by rail is shown in some statistics.[1] Of all the freight entering Mannheim, 5,608,000 tons, by far the largest part, came from the middle Rhine. Only 678,000 tons were received from the Prussian-Hessian railroad system, 170,000 tons from the Upper Rhine, and 1,293,000 tons by rail from Baden and Bavaria. The pre-

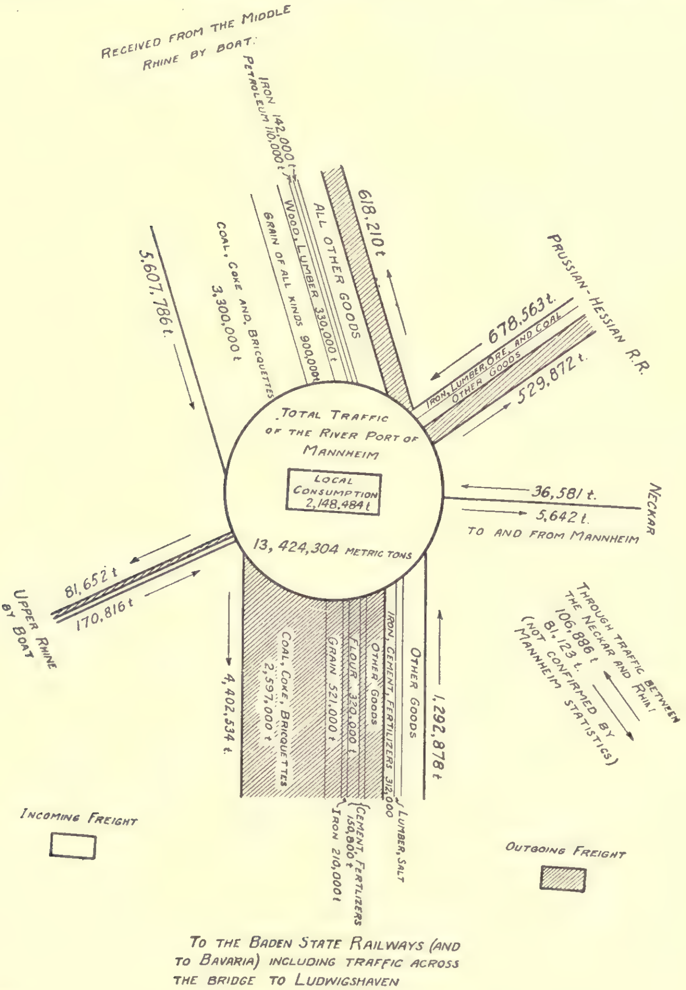

Received from the Middle Rhine by boat.
Iron 142,000 t
Petroleum 110,000 t
618,210 t
All other goods
Wood, Lumber 330,000 t
Grain of all kinds 900,000 t
Coal, Coke and Bricquettes 3,300,000 t
5,607,786 t.
Prussian-Hessian R.R.
678,563 t.
Iron, Lumber, Ore, and Coal
Other Goods
529,872 t.
Total Traffic of the River Port of Mannheim
Local Consumption 2,148,484 t
13,424,304 metric tons
36,581 t.
5,642 t.
Neckar
to and from Mannheim
Through traffic between the Neckar and Rhine
106,886 t
81,123 t.
(not confirmed by Mannheim statistics)
81,652 t
170,816 t
Upper Rhine by Boat
4,402,534 t.
Coal, Coke, Bricquettes 2,597,000 t
Grain 521,000 t
Flour 320,000 t
Other Goods
Iron, Cement, Fertilizers 312,000
Other Goods
1,292,878 t
Iron 210,000 t
Cement, Fertlizers 150,800 t
Lumber, Salt
Incoming Freight
Outgoing Freight
To the Baden State Railways (and to Bavaria) including traffic across the bridge to Ludwigshaven

Fig. 100.—Total goods traffic of the Inland River Port of Mannheim, 1911. This shows a river port as a link between river commerce (above) and rail commerce (below).

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[1] Taken from a pamphlet issued by the Mannheim Chamber of Commerce.

ponderance of transit freight is evident since of a total movement of 13,424,000 tons at Mannheim, only 2,000,000 tons were for local consumption. Of the total freight entering Mannheim, 4,403,000 tons go into Bavaria and Baden by rail, being transshipped in the port of Mannheim; 530,000 tons into Prussia and Hessia by rail. It can be seen that the traffic is almost entirely one way. The reason is that far more than half of all the freight received from the middle Rhine, and transshipped to the rail carrier for the interior consists of coal (3,300,000 tons) and of grain (nearly 1,000,000 tons). As these commodities are for consumption in South Germany there is only a one-way movement. The products from the engines and the labor which consumed these quantities of materials are often shipped out by water.

The River Port of Duisburg.—The word coal takes us immediately to the other great port of the Rhine—that of Duisburg—Rührort. In 1912 at this port 24,650,000 tons of goods were moved in 74,800 vessels. Of these vessels 71,561 were towed barges and 3,248 were power vessels. In the case of Duisburg we find the loading is from railroad to barge with a total movement of 15,000,000 metric tons, as compared to 2,600,000 metric tons loaded from barge to rail. These statistics simply show that at the inland harbor of Duisburg the movement is quite different from that at Mannheim. Duisburg is the source of the coal for which Mannheim is the transshipping point where the coal is loaded back into railroad cars for the remainder of the journey to the consumer. Coal is brought to the port of Duisburg in railroad cars, dumped into river barges by mechanical car-tippers, of which there are 29, beside much other equipment, then carried by water to Mannheim, where the coal is again loaded by mechanical means into the railroad cars for distribution in Bavaria. Even in so small a country it is still profitable to handle coal from car to barge and then from barge to car rather than to clutter up the railroads across the entire country with a long haul of coal.

To go back a moment to Mannheim. How has Mannheim been affected by cheap transportation of raw materials? Between 1860 and 1917 the wealth of the town increased from 453 million to 7,643 million Marks. Fifty-seven and a half per cent. of the population employed are engaged in industry and of this number the metal and machine industries claim over 20,000 employees. The reason of this growth is not to be found in any particular superior ability in the people of Mannheim, but in the mere fact that raw materials from all over the world, through Rotterdam, and in particular coal, and pig iron, and steel half products from the industrial districts of the lower Rhine, may be brought directly into the manufacturing plants of Mannheim by water at a low expense.

What *Le Génie Civil* points out to France, in the cases of Frankfort, Neuss, Düsseldorf and other river ports which have become great through water transportation, applies to hundreds of towns along the Mississippi River and the Barge Canal. Cheap transportation by water for low grade products at any point will make the industries thrive at that point. As the industries thrive the railroads will have an increased business hauling the finished products.

An English Engineer, Mr. Lindley,[1] who made a report on German waterways to his government a few years ago, says that goods traffic on the waterways for a period of 30 years, from 1875 to 1905, shows that in 1905, the length of the waterways remaining the same, the traffic had increased from 1,800,000,000 ton-miles to 9,300,000,000 ton-miles, or more than five-fold. Recent advancement had been at an even greater rate, both railroads and waterways progressing side by side, the waterways doing the dirty work, as it were, while the railroads continued to have an increased percentage of high class freight.

River Port Competition.—Competition in port development, commercial and industrial, between cities located on inland waterways is very keen and has been productive of modern terminal facilities. To quote from the Proceedings of the Barge Canal Terminal Commission, page 342, we find the following summary of the competition between cities: "The different cities along the Rhine are in the keenest competition with each other, a circumstance which has a tendency to keep the cost of water-borne freight at its minimum, thus greatly promoting the growth of industries all along its banks and attracting to the Rhine cities the establishment of large industries because of the incomparable cheapness of water transport. So keen is the competition between the different cities, even those of modest size, that they do not hesitate to spend millions of dollars of their own money entirely upon developments and improvements, sheds, cranes, and other facilities for accommodating and handling freight, which sums are, generally speaking, forever sunk in the undertaking, it being difficult and unusual for the cities that are thus improved to even obtain from the vessels, and the traffic that they transship, sufficient to enable them to meet the charges of maintenance and administration.

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[1] See *Proceedings* of the Barge Canal Terminal Commission, Albany, 1911.

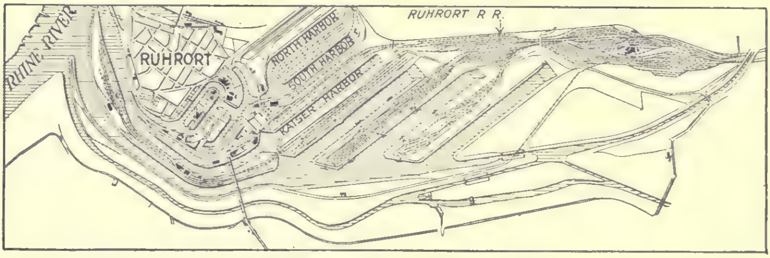
"The German officials with one accord assured the Commission that the direct losses they suffer in the construction, improvement, maintenance and administration of their harbors are not considered as an actual loss, the indirect benefits accruing to the cities, in the growth of industries, the employment they afford, and the workingmen they thus attract, much more than reimbursing the cities for their original expenditures, and for the direct losses incurred annually. These statements are borne out by the significant facts that the cities do not hesitate to make additional expenditures for further increasing their harbor facilities, and in seeing to it that the character of the equipment, consisting of warehouses, sheds, cranes, and railroads connections, is always up to the mark and abreast with modern development in respect to harbor construction and equipment. Thus it is that the Rhine River affords the most striking and superior, the most modern and most efficient, harbor development and equipment. Here it is, consequently, that the student of inland harbor development is able to observe the best there is to be found in the world."

Several points are opened for discussion by this statement, aside from the fact that it is distasteful to have to go to our country's enemy as a model in anything. In the first place, the matter of competition with the railroads. If the cities maintain the harbors, which correspond to the freight sheds and yards in a railroad system, and if the state, the Empire and municipalities maintain the waterways, which correspond to the right of way in the case of railroads, all for the benefit of the public, it is evident that the railroads as a private business enterprise are decidedly in a disadvantageous and a quite unjust position in competition with the waterways. The railroads must build and maintain their roadbed and their own terminals. A barge canal company operating on the Rhine or any other inland waterway pays small dues or even nothing at all for the use of the "roadbed." The water terminals, being built as a public utility, are frankly not intended to pay interest on the investment. Even in the state-owned Prussian-Hessian railroad system there is often opposition to the water competition because of this obvious inequality. However, as stated above, the railroads serve "local" points which are non-competitive with water-borne traffic. By connecting the non-competitive hinterland of the river ports a large volume of traffic area is opened and the roads may allow a substantial return on the investment. Even on the short haul, and much of it to the river port, the water-rail through rate is less and the roads themselves have done better financially than would have been possible through overburdening the tracks with low grade freight. A painstaking and thoughtful adjustment of the advantages of water transportation in connection with the railroads has been maintained, giving a low through rate, at the same time giving the railroads a comparatively higher per ton mileage rate than over long hauls in the United States. This entire adjustment and coöperation between the subsidized water and the unsubsidized rail freight should be quite possible under such an experienced organization as the Interstate Commerce Commission has become. One thing is obvious, however, that without such mediation, competition between railroads and water traffic in the United States will become chaotic. Such regulation should be a great boon to industry and a relief of rail congestion.

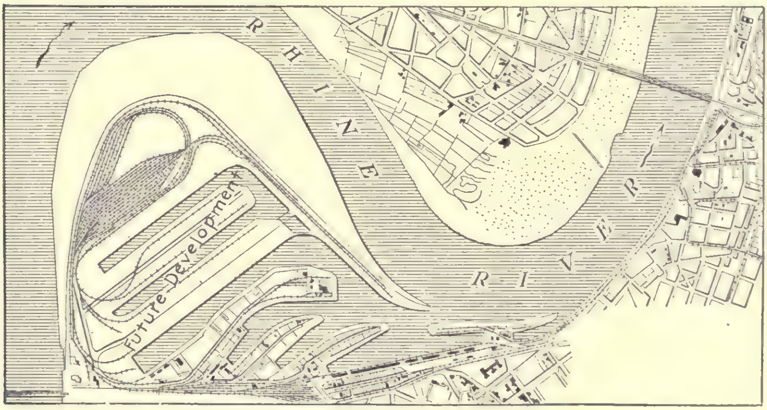
A national transportation system will call for the modification of some of the existing laws in the United States to allow railroad companies to operate their own lines of barges in connection with their rail lines. If the railroads are permitted to make the same rates as private firms, at the same time safeguarding the private firms from undue rate-cutting on the part of the railroad-canal lines, it will be an inducement to the railroads to short-haul themselves and to send bulk goods over their own barge line rather than by rail. As long as the railroads are forbidden to own and operate their own lines of barges they will naturally insist upon hauling bulk freight the entire distance over their own rail lines because of the advantages of the long haul.

Barge Terminals.—The success of water transportation is not determined alone by the efficiency of the terminals along its banks. Inland water transportation, aside from the mere engineering feature of constructing a channel, is a terminal problem just as is any other form of transportation. It is necessary to differentiate between (*a*) the canal terminal with little or no change in the water level, and (*b*) the river terminal with changes sometimes as much as 60 feet within a few hours, as along the Mississippi River. It is also necessary to distinguish between the industrial port and the commercial port.

A Commercial Port on a Canal (Figs. 101 and 102).—What should constitute a proper canal port or terminal for commercial traffic? The width of the canal will not allow large modern canal barges to lie along wharves without obstructing traffic. It is therefore evident that there should be certain basins or wharves of sufficient width to accommodate barges, loading and unloading, without interference with the traffic in stream. What *Le Génie Civil* terms *"le port interieur"* does not mean altogether an inland waterway port, but it means a port, inland or interior from the waterway. That is to say, barges must be given a haven away from the avenue of traffic where they may lie undisturbed while discharging and loading, or where they may be laid up awaiting orders to move. The effort to meet this need has not been made in France, and the German system has been proposed and advanced by several French writers during the present war. The



(From Report of N. Y. Barge Canal Terminal Commission)
Fig. 101.—River Port of Duisburg, Ruhrort.



(From Report of N. Y. Barge Canal Terminal Commission)
Fig. 102.—River Port of Duesseldorf.

ability to close such a basin by locks is of great advantage in the case of waterways having tidal or stream changes of water level. There is a decided limit to the effectiveness of locks in offsetting changes of water level, under conditions of extreme change as on the Mississippi, described below.

These basins or commercial harbors are cut into the land in the neighborhood of cities at convenient points of the topography. Figure 102 of Düsseldorf[1] will show a point of land in a sharp curve on the Rhine River used for this purpose. This point of land was of no value to the municipality for building purposes because it would be necessary to raise its banks and protect it from river floods. However, when it became advantageous to the municipality to construct a commercial harbor to accommodate the increasing traffic between Rotterdam and other river ports on the Rhine, this piece of municipally owned area was fastened upon as the proper spot. Basins were excavated and the spoil was used to fill up the banks to an above-high-water level.

The equipment of such a port does not vary essentially in detail from that of a seaport, except that the harbor works are not so large and the basins are not so deep. It is also imperative, in the case of river barges, to have freight-handling machinery for the quays, because such barges do not carry their own tackle and power for unloading. In the case of a river or canal port, therefore, mechanical means of unloading are a necessary provision on the part of the harbor authorities. The freight-handling machinery varies from the regular crane, handling miscellaneous cargo, to the ore-handling plants, in which the United States has surpassed all others.

It may be profitable to describe just one or two more of the Rhine ports as examples of what has been done in this particular phase of terminal development. The city of Düsseldorf has a population of about 400,000 inhabitants, is the seat of the great steel syndicate, the Steel Works Union, and of many plants manufacturing steel products. It is 100 miles from the Dutch frontier and about 200 miles from the sea. It is the center of a highly industrial and to some extent agricultural population of about 5,000,000 people within a radius of 20 miles, which gives the port an important hinterland. Fully one-third of the commerce consists of general merchandise. The people of Düsseldorf awoke to the opportunities of the harbor rather late, but set about to make up for lost time. About $3,000,000 was voted by the municipality, under the guidance of the Chamber of Commerce, for the construction of the basins, warehouses, sheds, quays, and cranes. There are five harbor basins with an area of approximately 160,000 to 170,000 square feet of water. The basins are about 250 feet wide, and accommodate river vessels drawing seven feet of water. Great warehouses and bonded warehouses are erected on ground leased from the city, and operated by private interests. The central power plant furnishes power and light for various duties including the working of 36 cranes. There are about 20 storehouses and sheds within the harbor area and upwards of 300 railroad cars are handled every day at 200 different loading places.

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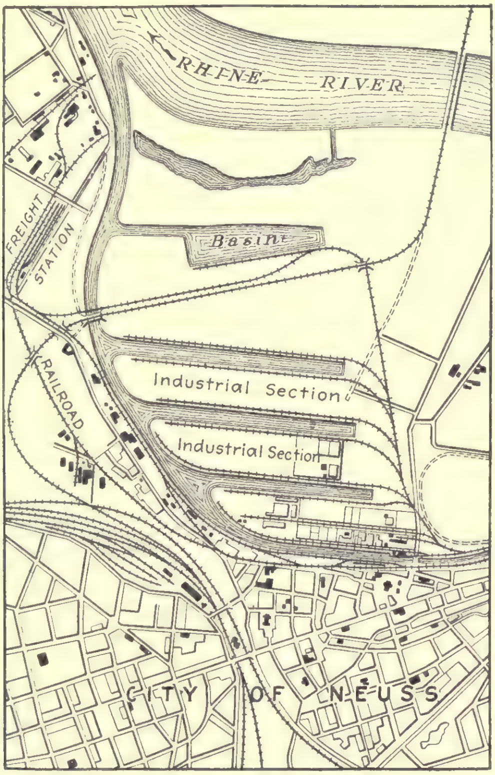
[1] From *Proceedings* of the Barge Canal Terminal Commission.

The fees for the use of equipment are not sufficient to pay interest on the invested capital and the city suffers an annual direct loss of about $135,000. The competition with other Rhine ports is so keen, however, and the general prosperity of the city has been so greatly advanced by the development of its harbor that the direct loss suffered is, in the view of the citizens of Düsseldorf, more than offset by the material and permanent gain to the city as a whole. As the city has local autonomy and can manage its own affairs, and as it has had experience both with and without a properly equipped harbor, its judgment that a commercial harbor, even when run at a loss is of greater advantage to the city than its cost is a valuable commentary.

The great coal harbor of Duisburg mentioned above cost $12,500,000 for construction and equipment. It contains about 667 acres of water surface and 408 acres of space for handling and storing freight and nearly 400 acres occupied by classification yards. The harbor railroad has 93 miles of trackage, the basins have a length of 8½ miles with an average depth of 15 feet. As this harbor is devoted almost entirely to coal, there are 250 loading platforms. Altogether there are 22 miles of wharfage, one commercial quay, being 3,550 feet long and equipped with 30 travelling cranes (Figs. 103 and 104).

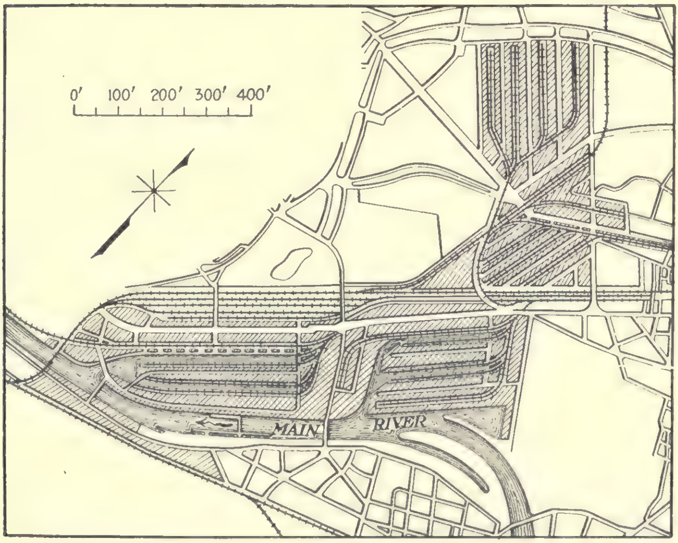
These examples will serve to illustrate the extent of development for two kinds of materials, general package freight in the commercial harbor of Düsseldorf, and coal at Duisburg.

Le Génie Civil seemed particularly interested in the harbor of Neuss, which is almost entirely an industrial harbor. The object of the industrial harbor is to afford manufacturing plants an



(*From Le Génie Civil, Paris Mai.* 1917)

FIG. 103.—Industrial and Commercial Port Area of Neuss.



(*From Le Génie Civil, Paris, Mai.* 1917)

FIG. 104.—Industrial and Commercial Port Area of Frankfort-on-the-Main.

attractive location as regards accessibility to raw materials by water, and rail connection for finished products by land. The port of Neuss, according to *Le Génie Civil* has 76,800 square meters (92,160 square yards) of water basins excavated out of the land, and 170,000 square meters (204,100 square yards) of building sites and other land. In addition to the industrial area the city contains a commercial terminal with eight electric cranes and two steam derricks. But the larger part of the port is devoted to industrial enterprises.

In the case of Frankfort-on-the-Main, according to *Le Génie Civil,* the harbor area consists of 472 hectar (5,664,000 square yards) of which 288 hectar (345,600 square yards) are devoted to an industrial area. Frankfort-on-the-Main spent 24,000,000 Marks ($6,000,000) to acquire the land, 40,000,000 Marks ($10,000,000) for the installation of the harbor works, and 8,000,000 Marks ($2,000,000) for general expenses.

Although these river ports are taken as typical, an enumeration of fully equipped and scientifically constructed inland waterway terminals would mean the calling of a roll of some hundred or more cities, which would not be profitable at the present time. The point which is being made is this: that the French and also the Americans are waking up to the fact that to meet German competition after the great war, it is quite necessary to consider the water and rail transportation factors, and the possibilities of developing through municipal aid and effort, such commercial port and industrial areas on navigable inland waterways.

The entire problem of developing the upland and connecting it with navigable waterways will be considered in the next chapter. In the meantime, let us proceed to the consideration of the peculiar problems concerned in river terminals with great water level variations, particularly in connection with the Mississippi River.

Mississippi River Ports and the Water Level.—The terminal situation on the Mississippi and its affluents, as on many other rivers, is complicated by the fact that the river may rise 40 to 50 feet within a few hours. Boats loading and discharging from side ports over long gang planks can not negotiate a fixed wharf from such ranges of water level, granted a fixed or permanent wharf be constructed. Usually, there is only a muddy bank. To meet the difficulty of high banks and variable water level there has been designed a river terminal of two parts. The transit shed and warehouse portion, with a crane or two, and spur tracks at the land side, is well above high water. A pontoon, which rises and falls with the water level of the river acts as a floating wharf apron. It is held in position by iron loops

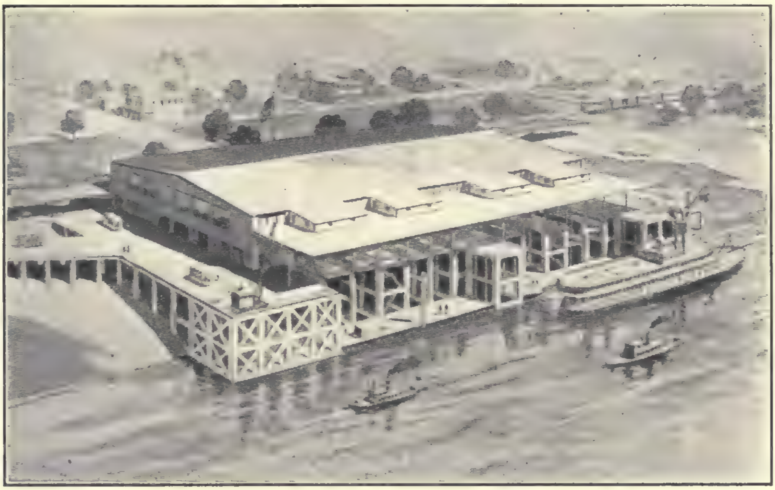


Fig. 104*a*.—A modern efficient river terminal designed by *Cleveland Dock and Engineering Co.*

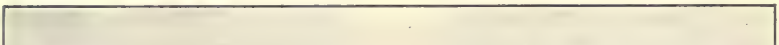
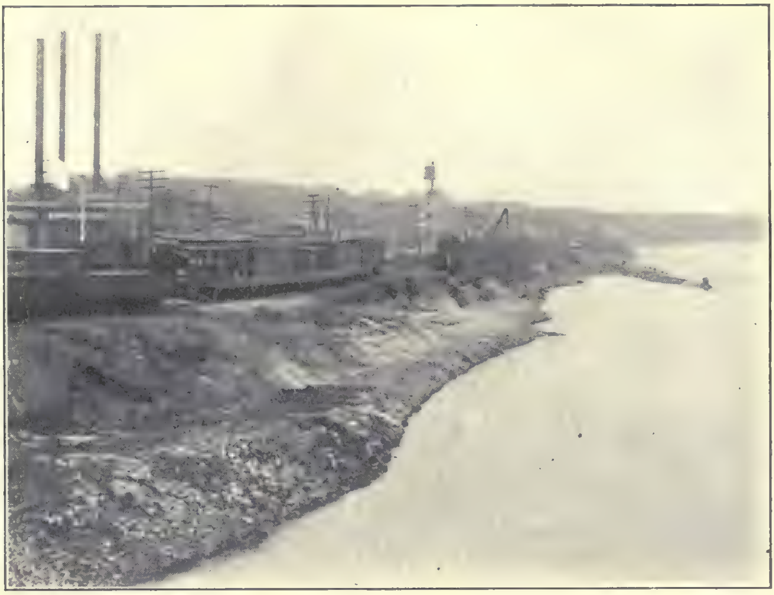


Fig. 105.—Antwerp. Large floating pontoon. Similar to the "Princess Landing Stage" at Liverpool. To accommodate a wide range of tide.



(Courtesy J. B. Hasteller)

FIG. 106.—Davenport, Iowa. Railbound waterfront.

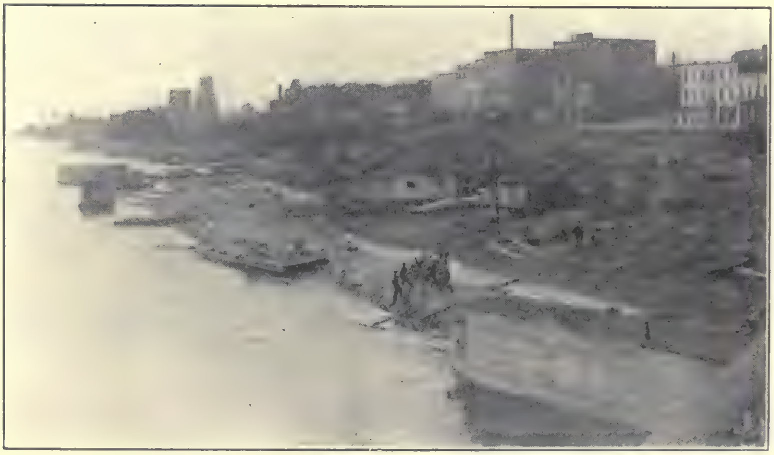


FIG. 107.—Clinton, Iowa. A neglected opportunity.

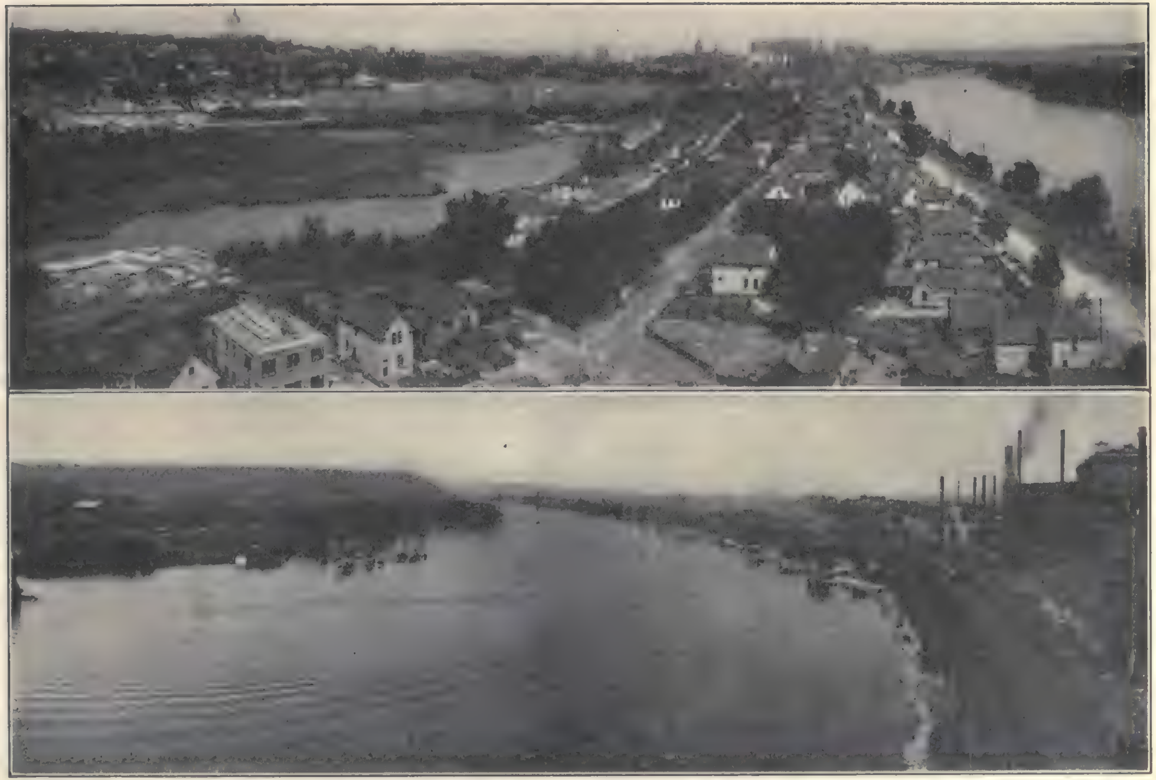


FIG. 108.—St. Paul, Minn. The low land, part of it under water, would be the ideal spot for a dug harbor. Coal could come from Ohio and flour and grain exported via New Orleans. Another example of an iron bound waterfront. The land in the distance of the left of the tracks is the promising site for a commercial port.

around the piling. This is the same sort of a pontoon, only on a smaller scale, as the Princes Landing Stage at Liverpool, or the landing at Antwerp. Freight is discharged from the boat to the pontoon which remains at the same level as the ports at all tides. From the pontoon it is raised to the shed floor by elevators or by the familiar warehouse whip hoists or fall rope and drum. Such terminals would go far toward solving the terminal question for smaller communities on a river with wide changes of water level. The sections are comparatively simple and inexpensive to build. As the commerce of the port increases, the terminal may be enlarged, a section at a time.

An idea of the present neglect of opportunities on our greatest waterway may be obtained from a few illustrations.

In conclusion it may be repeated that the great ports of Europe have been those which have both rail and water connection with the interior. The port with the widest choice of communication with the interior by land and by water will become the greatest port. From this it may be deduced that with the Hudson Valley, the most populous section of the State of New York, and the entire Lake Champlain and Great Lake region connected with New York by water, as well as all the area tapped by some 27,000 miles of railroad, New York looks forward to a future growth not yet imagined. Likewise with New Orleans at the point of transshipment from ocean carrier and barge, with the great Mississippi Valley and also the Great Lakes area served by water transportation in addition to the present and future railways, the possibilities of expansion stagger the imagination. The time has come when these opportunities should be realized. The key to the situation is rail coöperation and the construction of proper terminals (Figs. 106, 107 and 108).

CHAPTER XVI

THE INDUSTRIAL HARBOR AND UPLAND DEVELOPMENT

It is hardly possible to discuss the industrial harbor without discussing upland development. Each involves a close study of land values. The desirability of property for industrial enterprises is determined by its proximity to centers of commercial intercourse and to means of transportation. The forces involved are most easily seen in the case of passenger traffic. We have two illustrations in New York. One of them is the "City" or Wall Street district of high land values where it is desirable to be within walking distance from the centers of commerce. Here the increase in land values made essential better utilization of the land by the application of more capital in the shape of higher buildings. The ability to increase the return on a given plot of land by the application of more capital and labor in the shape of higher buildings again increased the value of the land by increasing its ability to yield a still greater return. The value of land depends upon the income it will yield in connection with the application of capital and labor. This reciprocal action between the additions of capital improvements and the increase in the value of the site of the piece of land has driven the ground rent of property in immediate proximity to the center of finance to unheard-of heights quite irrespective of the fact that there is plenty of cheap land in the Dakotas. The land, together with the capital applied to it, has been able to satisfy the demand of more individuals who desire to be within walking distance of Wall Street.

Likewise the converging of rail, surface, 'bus and subway lines has increased the accessibility of the neighborhood of Forty Second Street and Fifth Avenue for shoppers and travellers. Therefore the desirability of this location for buildings devoted to clubs, hotels, shops, and offices has increased the demand for and price of lots. The application of capital for improvements in the land in the shape of luxurious hotels, shops, the Buyers'

Club, etc., has been profitable. The foundation of the land value is the accessibility of the land because of transportation facilities which makes it more productive and therefore more desirable.

Industrial sites are less conspicuous examples of the same laws of site rent in operation. An undertaking of a manufacturing nature desires to be both at the center of commerce and at the point of transportation accessibility.

In order to understand the problem of upland development in the following pages the theory of land value must be kept well in mind in order to evolve the most practical plan of harbor layout.

First we have the productivity theory of land value. This theory has just been pointed out by the two New York examples. The value of land is determined by the amount which one piece of land as compared to another piece of land contributes to the value of the product for which the piece of land is used. It is apparent, however, that the land itself becomes more productive with the judicious application of capital. However, with the same application of capital in the shape of buildings one piece of land because of its location will yield a greater return than another piece of land, and therefore will be more valuable—because of its greater productivity. The demand for that more productive piece of land will be greater and the price which one is willing to pay for it will be greater. The price will not reach a figure that will not return a fair income from the capital and land (now capitalized in the price) working together. There is therefore a limit to the price of land set by the productivity of that land as compared to other land.

Likewise land value is said to be determined by the cost. In the case of site rent—the value due to location—the cost of building the means of communication which will give the land the desired accessibility determines the value of the land. The supply of land with improved traffic conditions will be influenced by the cost of creating the means of transportation. In fact the cost of creating the desirable conditions will put a very positive check on the supply.

Now, price is determined by supply and demand, but the demand will not increase the price of land beyond its productivity, and the supply will not be decreased until the price falls below cost. The answer to the question, "Will it pay?", depends on these two limits.

Also the use to which land is put ranges from the intensive application of capital, such as the Woolworth Building or the Hotel Commodore, to the extensive use of the land for a ship yard, a gas works, or other industry which requires much ground room. Of course, the ship yard would like to locate on the west side of Manhattan, but the return is too little to cover the ground rent, as it is determined by the more productive enterprises at that location. The more extensive enterprises, therefore, must move away from the centers of commerce, desirable though that location may be. The cost will otherwise exceed the productivity.

Keeping these principles in mind let us consider the case of the industrial harbor. The location of industry within the corporate limits of a municipality or a state is of great indirect advantage to that political unit. The industry pays wages and salaries to many people who buy or rent homes and increase land values, which also increases the land tax income. The salaries and wages are spent in the shops and markets of the community, which increases the volume of business done, which again increases the income of the municipality, through the income and land taxes. The bank clearings are increased in the same manner and with the same effects of quickening business and increasing the income of the local government by various direct and indirect methods of taxation.

One good way to attract industry has been to offer advantages of location in regard to transportation. In the United States the number of railroads entering the city has been the drawing card. In Europe the municipalities and states have long since considered the rail transportation, under Government ownership or control, as a matter of course and have applied themselves to the development of water transportation as an additional attraction. The municipalities have gone to great expense to build and equip water transportation facilities in connection with industrial building sites. A glance at any of the maps of recent river or seaports in Europe will show the extent of the "*terrain industrial,*" or *Industrie Gebiet,* or whatever its name may be. The Germans have gone the furthest in the actual execution of industrial harbor works, but the planned extensions of Antwerp, Bordeaux, and many other cities include vast areas of upland destined for industries. The industrial port is primarily a canal adjunct even at the seaport because the productivity of deep water-front by intensive development is too great to admit of its use for general industries.

The European municipalities have sought to promote the common welfare by building the necessary harbor works and attracting to them the heavy industries which are most interested in low freights. For instance, when the International Harvester Co. was about to build a large factory in Germany, the various municipalities sent their committees to present the points of advantage of their municipality as the most economical location for a large factory. Magdeburg offered an extensive area on the Elbe to the north of the city with a municipal wharf improvement included. This location would have been midway on the great Elbe water thoroughfare from the port of Hamburg to Bohemia, and also in the very center of a great railroad net.

But there were competitors. The town of Neuss had tapped the Rhine water highway and built canal side arms and basins giving direct waterfront to many acres of industrial sites. This location gave canal barge access to the Port of Rotterdam and to the great coal fields. In other words the accessibility of raw materials was better at Neuss; at Magdeburg the distribution of the finished products was better. From this analysis, other things being equal, the Neuss location was better. Raw materials have far less specific value, that is, greater weight and low value, and are less able to bear the traffic expense. But other things were not equal. The town of Neuss in addition offered the terrain at a low figure and rebated the taxes on the enterprise for ten years. It is usual in these municipal industrial harbors to lease the harbor sites for a term of years and not to sell the land. The Neuss salesman cut prices, if you will, but got the big industry to locate at his city. Municipal salesmanship is as important as any other branch of the science of how to get the signature on the dotted line.

Now how about Neuss? The return to the city from the indirect result of the industry locating there is great. We saw this fact above. But lease rentals from the industrial terrain located at the expensive harbor basins do not pay interest and maintenance on the large investment. The deficit is made good every year out of the taxes, and the harbor is an expense in the city budget. Few if any of these municipal industrial harbors have been self-supporting. They seldom have paid interest on the investment and maintenance. Even if the various municipalities have continued to build and operate industrial harbors at a loss because the indirect value of the industries attracted to them has been a benefit to the community in general, the question arises, is this loss actually necessary?

In the United States we have not yet arrived at the stage of the development of the municipal harbor except in the case of a few seaports. This backwardness in America may be an advantage of importance. Our lack of progress in this connection may be our good fortune. As the situation of the industrial harbor is studied it will become apparent that it should not be necessary to operate such an expensive institution at a loss if it be properly designed and equipped in the beginning. With the opening of the Barge Canal, and the development of the long neglected possibilities of the Mississippi as the greatest water highroad in the world, the question of the industrial river port will be acute. The question already is acute in the case of the Jamaica Bay Improvement, that of Newark Bay, of Lake Washington at Seattle, and many others.

The problem is how to tap the upland. It is how to extend the benefits of the waterfront to the maximum distance inland. It is axiomatic that the deep waterfront must not be misappropriated for any other use than that of transshipment. Shipbuilding is an exception. The degree of the success of this effort to extend the benefits of the water connection to the upland determines the possibility of spreading the cost of harbor works over a sufficient area of land to make the cost of the area less than the productivity. The municipality must bear the burden of the difference or no industry can afford to locate there. If the cost of the terrain can be lowered the city may save money to carry out other important works. This relation of cost of construction to area served in relation to the mechanical connection which may be established is expressed in the following formula:

The proportionate cost of harbor improvement of a given unit of waterfront varies inversely as the depth of the piece of property served by the waterfront.

If a piece of waterfront cost $100 per linear foot to improve (dredging of basins and channel, retaining walls, transshipping machinery, etc.), and the adjacent upland is 100 feet deep, the portion of cost per square foot will be $1.00. If the depth be 200 feet the proportion will be fifty cents. If it be 1,000 feet it will be 10 cents providing the additional upland can be made accessible at low expense.

However, the cost of communication with the upland also increases with the distance. The result of the two forces is a formula something like this:

$$X = \frac{(l \times L) + (M \times D) + C}{D \times l}$$

X = cost of each square foot of upland area.
l = length of waterfront served by mechanical equipment.
L = cost of harbor works per linear foot of waterfront.
M = cost per foot of mechanical connection between waterfront machinery and upland.
D = depth of the piece of property measured from the water in feet.
C = original cost of land.

It is evident from the nature of the equation that there will be decreasing cost to the point of diminishing returns. If plotted on a graph the cost of harbor upland would give a U-shaped curve. When the cost of mechanical connection ($M \times D$) together with the original cost of harbor works grows greater as D is increased, instead of less, the conomic limit of the depth of the upland has been reached. The variable is M. If means can be designed with such engineering skill that $M \times D$ remains relatively small, D may be increased to several hundred feet before diminishing returns become evident.

The problem therefore is to increase the depth of the property as compared to the waterfront by mechanical means of communication.

Character of Industries Interested in Water Connection.—Before discussing the engineering problems involved it may be well to consider for a moment the character of the industries benefited and attracted to the industrial harbor. Any industry which utilizes large quantities of bulk material of a low specific value finds the element of transportation expenses the greatest problem of the business. Coal, ore, sand, clay cement, pig iron, cotton, and petroleum are the most important bulk commodities. Such industries as smelters, gas plants with coke ovens, electrical power plants and foundries, cement works, calcium carbide works, and also higher grades of production such as heavy machinery, pipe, structural steel, boiler factories, building materials of all sorts, brickyards, tile works, glass factories, and countless similar industries require large quantities of fuel and materials.

A location which affords easy transportation by both water and rail will have an increased value in proportion to the saving in the final cost of production which this location affords as compared to other less favorably located industries.

The heavy industries are the ones which the various municipalities desire to attract by building industrial harbors. It is also a far-sighted policy to attract the industries whose products are the foundation for more refined manufacturing. If by reduced transportation costs it be possible to produce the half products at less cost, these half products which are the raw materials of the lighter industries will be available at lower cost. The heavy industry at the well developed industrial harbor will be able to quote lower prices on half products and thereby make it of decided advantage for the light industries to locate at the same town in order to be at the source of the needed materials. This is the economic foundation for the rapid growth of Gary, Ind., far beyond the direct requirements of the United States Steel plant.

The Mechanical Problem of the Upland.—There is a decided difference between handling the materials for an industry for shipment and handling the products of a mine. The difference is in the quantity which must be handled within a short space of time. No ordinary industry needs to fill a 12,000-ton ship in 39 minutes or discharge it in 2½ hours. A plant which requires this amount in a day or even a week is a large one. Many large plants do not use more than 50 tons of fuel and material an hour. The problem is therefore not so much one of speed and quantity, as one of cheapness and the minimum of supervision.

The problem of how to hold the boat for the shortest possible time is also not of first rank importance as in commercial harbors or Lake navigation. The reason is that industrial plants, except the very large ones, do not receive their materials or ship their products in steamer-load lots. The usual vessel is a canal or river barge or harbor lighter. The capital investment is not so great per capacity because these barges and lighters are towed and not propelled by their own power plant. They are brought alongside the wharf of the industry and left there for loading or discharging. This may proceed at a leisurely rate without the interest on the investment becoming a controlling factor. The industrial wharf is usually a barge or lighter wharf. A notable exception may be made in the case of the great steel plants on the Lakes, using the large Lake steamboats described above.

Side Arm Canals.—The usual method of opening the upland in municipal industrial ports has been to tap the main waterway by a system of side arm canals, wherever the nature of the land makes this possible. Such side arm canals must be as deep as the fairway, for they are to accommodate the same barges that navigate the main waterway and river craft. At a seaport the depth should be sufficient to accommodate lighters.

The expense of such harbor construction differs widely according to the geology of the country. In low marshy land, such as the Hackensack meadows, the Newark Bay territory, or the flats about Detroit, it is about as simple to run canals and fill the land with the spoil as any other method of reclamation. Therefore, with easy dredging, the system is more efficient and cheaper per square foot of territory served than almost any method of opening the upland.

In the same ratio as the difficulty and expense of constructing side canals increase, so also does the necessity of making the water connections farther apart so as not to overload the cost of the industrial area served. The connection with the upland by mechanical means is increased in length as the canals are built farther apart. The practice of too frequent canals, as shown by the maps of famous river ports, involved too great an investment in harbor works to be economical. The territory served is too small to allow of sufficient diffusion of the initial costs over the area. It is also evident that side canals above the least possible number will not only add to the cost of the works, but will put too much land under water. The loss of space occupied by the canals will bear too large a proportion to the whole and also add to the cost per square foot of building sites.

If dredging conditions permit of frequent canals it may be possible to allow the industries on certain canals to extend their buildings to the water's edge. When the canals are far apart a marginal way for public use should be left connecting the wharf with the upland. In this case the conveying machinery should not be at grade, but at sufficient height to allow the passage of vehicles under the conveying machinery. Fortunately most conveyors operate normally at a high elevation in order to accommodate stock piles of materials.

When the river port has been built at large expense because of the firmness and elevation above water level of the upland, the industrial terrain can not be served by canals at all. In this case the port proper, the transshipping point, must be connected by railroad tracks and the connection with the waterfront maintained by cars with switch engines. The map of the river port and industrial area of Frankfort-on-the-Main will illustrate this.[1] The industrial lofts of the Bush Terminals also follow this system. At the Bush Terminals the industries which are engaged in light manufacturing do not have the same vital interest in immediate connection with the water as, for instance, the many power houses around the Manhattan waterfront, whose need of immediate transfer of coal from barge to bins makes it worth while to occupy even valuable Manhattan waterfront to accomplish a saving in coal transportation. The port should be planned to allow an open wharf frontage for the public, even in such cases.

Bulkhead Connection.—At the Port of New York and many others where the difficulty of excavation makes upland development by canals out of the question, where there is a great length of natural shore line, and where the water off-shore is wide enough to allow of pier construction, the upland may be opened for heavy industries without withdrawing the valuable waterfront from its proper function as a transshipping point. The waterfront should carry the usual pier equipment with sheds and transfer machinery for ships. The piers, however, should be placed sufficiently far apart, at a distance of about 300 feet, to allow lighters, scows and barges sufficient length of bulkhead to lie alongside. The bulkhead would then be equipped with the necessary conveyors, to be described below, which would raise the material above the headroom level of the traffic of the marginal street and carry it across this to the industrial territory beyond. Such a system would preserve the waterfront for the intensive transshipping activities and at the same time relieve the industrial terrain from the largest part of the expense of the waterfront development. At the same time it would afford the industries all the advantages of cheap transfer of materials between water carriers.

The Mechanical Devices of Upland Connection.—There are three distinct classes of duty to be performed by the mechanical devices connecting the upland with the waterfront, which are determined by the amount of material to be moved.

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[1] *Le Génie Civil.*

Duty "A" which we may call "heavy" will require the movement of 250 to 350 tons of material an hour. This will require a pair of heavy-duty bridge cranes of the Brown Hoist Fast Plant type, or a Stuart System Belt Conveyor, piler and reclaimer (see Chapter XI). The industries requiring duty "A" are smelters, or iron or steel plants, using great quantities of coal and ore.

Duty "B" with a demand for the movement of 50 to 100 tons of material per hour will be met by a cable-crane or light bridge crane of considerable length inland and limited waterfront. Gas works, cement works, glass works, etc., will do very well with this service.

Duty "C" (light), will not require a service of greater capacity than 25 to 50 tons the hour. To this class belong all those industries which are engaged in the manufacture of more finished articles. Their chief requirement to be transported by water is fuel. The port area can be served by a telpher system with movable loop sidings to cover the various fuel piles.

It will be seen that each succeeding group has less waterfront and more upland. There are two reasons for this. First, the heavy-duty industry by handling many thousands of tons over the waterfront every year is able to dilute the higher fixed charges of greater waterfront and more expensive equipment, and thereby reduce the expense per ton. Also the higher speed of movement of the material makes it necessary to have the travelling buckets or cars or conveyors move shorter distances and make more trips.

Heavy Duty.—In the case of duty "A" the length of waterfront is far in excess of the length of the two barges for which provision has been made. The equipment for duty "A" is the same as that for ground storage of bulk products for transshipment. The advantage is with the Stuart System (Fig. 87, page 218) because of its saving of waterfront. The proportion of upland to waterfront shows a more favorable equation of cost distribution in this system.

Light Duty.—In the case of duty "B" there are other mechanical devices which are far less expensive in ground rent and in construction than any of the above methods. However, owing to the smaller ton capacity the cost per ton may not be less than the heavy-duty outfits handling thousands of tons every day.

The problem is therefore a different one. The object is to save ground rent by carrying a small amount of material farther upland.

This may be done by light-duty bridge cranes. A solution which has been very satisfactory in many European installations is the cableway, cable-crane, or cable-telpher. The general principle is the same as in the Brownhoist Rapid, the travelling hoist operating a grab bucket (clam-shell). However, the bucket capacity is less and the travel longer and this means fewer trips per hour. Reckoned on a ton for ton basis it is much less efficient. The first difference is that the water and plant ends move along the short side of the storage ground while the length is spanned by a cableway (or light bridge) instead of the heavy-duty bridge. Greater depth per linear foot of improved waterfront reduces the cost per unit of space. The possible span of the cableway is much longer for light duty than the bridge. Therefore with the movement of material required to supply only one plant of reasonable capacity the advantage of layout is with duty "B." The equation shows a lower total cost of handling material due to the better utilization of the upland. Cables with the capacity of loads of 12 tons and a span of 1,500 feet are not unusual.

Light Special Duty.—Duty "C" involves less movement measured in tons, but over longer distances and with more diversified loads. The most important movement as a rule is to get fuel in and ashes out. There is other waste or refuse from the plant and sometimes part of the products of the plant to be moved to barges, scows, or lighters at the waterfront. As long as the size and weight of the loads are reasonably uniform there is no great difficulty in supplying mechanical equipment.

In opening the upland of a municipal industrial harbor the practice has been for the city to build side canals. Therefore, there should be nothing unseemly about having the city supply a common telpher trunk line to the waterfront, *i.e.*, an uncommon telpher to be used in common. The side loops would be provided by the occupant of the factory site and also the rolling stock, according to the size and nature of the loads. A cotton merchant would have a set of motor-driven telpher cars to carry cotton, the oil merchant the same with the proper slings for carrying barrels, etc. The rolling stock could be of the man-trolley or of the automatic type.

Mr. John R. Fordyce[1] has built several installations of this character for private companies at Texas City and Mobile, Ala. The entire principle involved is shown by the photographs and drawings and described in his letter to the author (Figs. 109 and 110).

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[1] Now Major of Engineers, U. S. R.

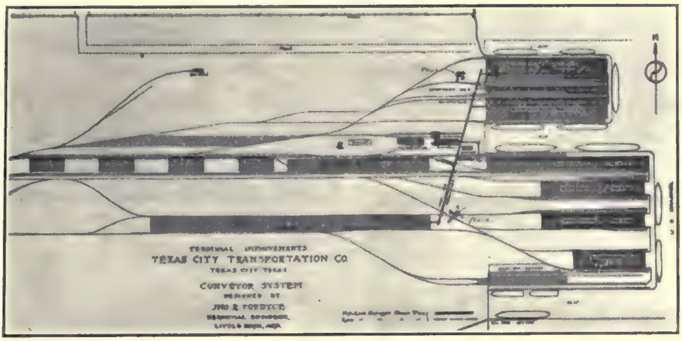

FIG. 109.—Terminal improvements, Texas City Transportation Co. Showing route of overhead monorail conveyor connecting wharves and cotton warehouses.

"I am enclosing copies of photographs which show the trolley system which was constructed at Texas City, Texas. I am also sending a small outline map and indicating on it the points from which the photographs were made.

"From the map and the description which I have copied from the Manufacturers' Record which was made by the Chief Engineer, you can get a very good idea of the structure. The total cost of the double track high-line and the extended low-lines in the warehouses and wharves was $36,000.

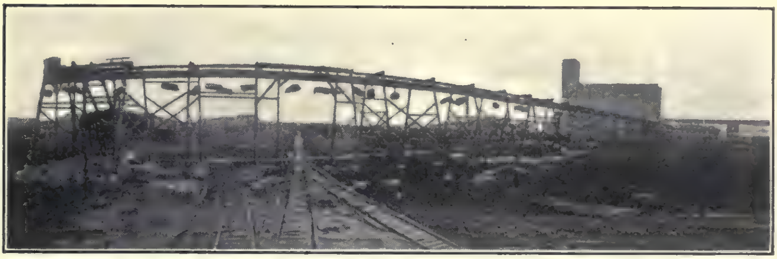

FIG. 110.—Fordyce Installation at Texas City. Cotton transfer from warehouses to ship by overhead trolley.

"If the cotton bales can be fed up to the base of the incline as rapidly as the high-line conveyor can take them, it would be possible to put over from Compress No. 1 to shipside at the end of warehouses A and D, 14,000 bales of cotton in 24 hours. The maximum speed of loading a ship by the methods now in use is not more than 2,500 bales in 24 hours, so that you can see that we can supply cotton enough to load simultaneously about five ships.

"This plan was contrasted with a plan of using an electrically driven telpher which was to operate from the high-line only, and two machines picking up cotton at the east end of Compress No. 1 and delivering it to the west end of either warehouse A or warehouse D. These were able to handle 2,000 bales in 24 hours, so it would have taken about seven days to accomplish in that manner what this continuous conveyor system does in one. In addition to that, the structure of the high-line had to be strong enough to support a concentrated load of forty bales, together with the heavy telpher machines. This structure alone, and the two machines, had an estimated cost of $40,000.

"As an indication of saving brought about by this conveyor system, will say that it costs about three cents per bale now to transport over to the warehouses, where it formerly cost 13 cents per bale to load the cotton into railway cars way back at the ladder tracks, then switch it onto the proper lead and switch it then to the warehouse at the wharf. Another thing in favor of this telpher system was that cotton could commence to be delivered immediately after the order to move was given, whereas by the railway car method, it was necessary to load at least five or six cars before it was worth while for the switch engine to move them.

Monorail for Quickly Loading Cotton on Ships at Texas City.—"The Texas City Transportation Co. has installed a monorail system to facilitate the handling of cotton from the compresses and warehouses to shipside. More than a mile of monorail is in operation, with a capacity at maximum of 10 bales of cotton per minute, or 600 per hour, from compress to warehouse or shipside.

"A monorail, as the name implies, is a single light rail over which commodities may be transferred, usually from one warehouse to another or from points in the same building. The rail is ordinarily fastened to steel "I" beams, channels, or wooden beams, and is equipped with a roller contrivance from which are suspended the articles of merchandise, etc. These rollers may be moved by hand, wire cables, or chains, or, in some cases, the track is inclined, the rollers then being operated by gravity.

"The monorail system in Texas City is of a special type, and to-day is the only one of its kind in existence. The system is divided into two sections. First, the low-level lines, totaling about one mile in length. These lines are placed in the warehouses or cotton compresses and attached to wooden brackets about seven feet above the floor. These are feeder lines. Second, the high-level lines, placed outside the buildings and extending over the railway tracks for a distance of 1,200 feet. The low-level lines are connected with the high lines by inclined trackways.

The high-line track is about 34 feet high, and is suspended from heavy wooden "A"-shaped frames.

"On the high line, about 14 inches above the rail, are two small angle irons which make a trackway for the heavy, endless ice chain. This chain is fitted with pushers, one every 10 feet, and with rollers similar to skate rollers, also every 10 feet; as the high line is double tracked, this chain is approximately 2,400 feet in length. There are frequently 240 bales of cotton in the air, all moving at about one-third the rate of a walking person. This chain is operated by a 15-horse-power electric motor. The inclined lines have a similar chain, but operated with lighter motors. One of the tracks of the high line is used for the return of empty trolleys, which are automatically discharged at any desired warehouse, and a retarding motor delivers the trolleys to the low line with a uniform speed. The ascending motor automatically delivers the loaded trolleys to the high line.

"The trolley to which the hooks supporting the cotton bales are attached resembles the letter "J," the stem being fastened to two ball-bearing rollers that fit the rail, the crooked part being perforated to permit the passage of a chain with two hooks suspended in equilibrium. On the low-level lines one man is capable of pushing 10 bales of cotton, or, by giving each bale a sudden push, he can advance it about 200 feet, so that by stationing men every 200 feet cotton can be rushed to the high line with great speed. With all of the motors in operation, cotton may be delivered to warehouse or shipside at the rate of 10 bales per minute, or 600 bales per hour. Each warehouse, as well as each incline, is equipped with switches to divert the empty or loaded hooks.

"The greatest future possibility that I see in such a system is that it enables warehouses located back away from the waterfront to be coupled up to the waterfront by a light, cheap, overhead structure, on which continuous delivery of freight can be carried on above the congested railroad yards and the congested street traffic, which always is present at much-used ports.

"I am also enclosing a map of a little layout which I got up to be used in the City of Mobile. Here there were three owners of the wharf front, the Southern Railway, the M. & O. Railway, and the Municipality of Mobile.

"The large warehouse area located west of Commerce St. was cut off from the waterfront by the fact that the main line of the L. & N. to New Orleans passes along Commerce St., and it was stated that, in order to load a ship anywhere on the waterfront, with material which had been stored in warehouses or which came in by cars over the Southern and the M. & O. Railway, there was a delay of at least seven hours, due to the constant interruption of traffic by the passing of trains on the L. & N. Railway.

"Another fact that appealed to the city was that the small piers and warehouses situated on them could be used as unloading platforms and not as storage warehouses. By installing this system of conveyor into all storage warehouses back in warehouse area, material could be quickly transported to any pier, and in consequence ships loading mixed material could direct their cargoes from various warehouses and not be compelled to change their berth.

"This project, however, has been postponed because of war conditions and is not now being put through. It was decided upon, however, by the engineers representing the various interests of Mobile, only after they had visited Texas City with me and had had an opportunity to see the Texas City conveyor in operation.

(Signed) J. R. Fordyce.

The point to be emphasized is that a municipality which builds a commercial port with an industrial port area may make the project pay by proper planning of the upland and by provision for proper connection with the same.

Three foreign layouts of upland connection are shown in Figs. 111, 112, 113.

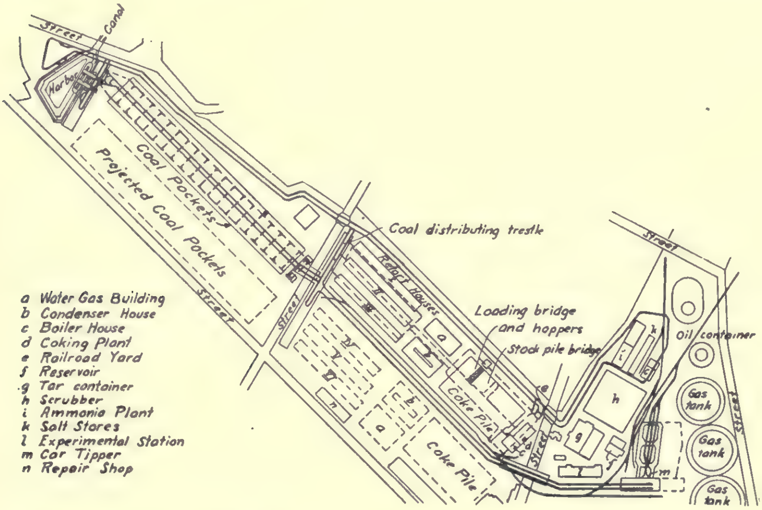

FIG. 111.—Small harbor and extensive upland of the Berlin-Tegel gasworks served from small side-arm canal. Connection by means of overhead monorail system.

Newark Bay, Jamaica Bay, and Others.—There has been much agitation for industrial harbor improvement during the past few years. The areas where the projects are to be carried out are most promising of successful results as *industrial* ports. It is

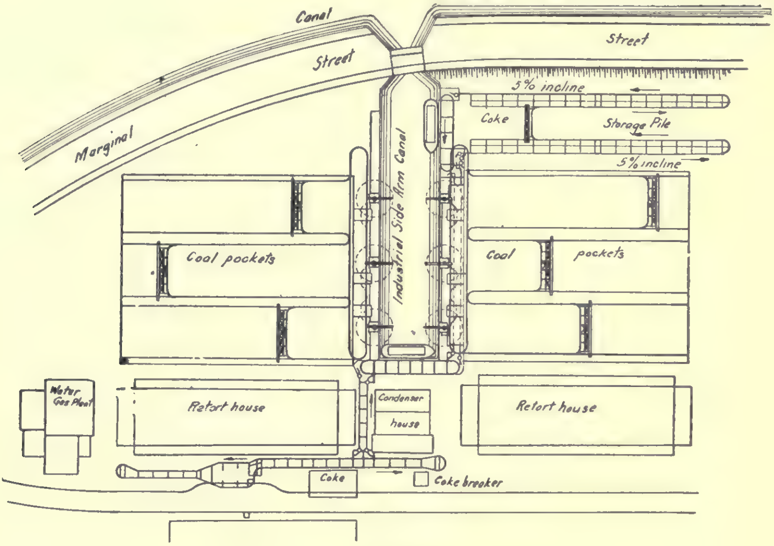

FIG. 112.—Crane unloading and telfer transfer system of a gas plant.

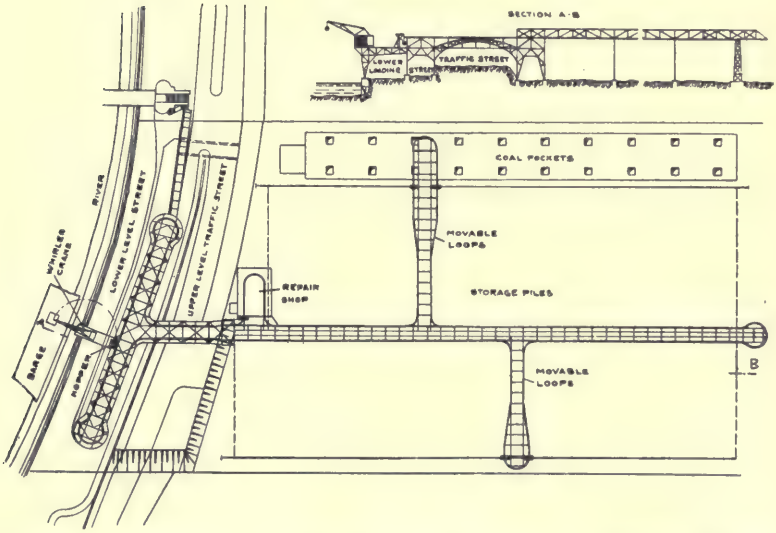

FIG. 113.—Layout for a coal company. Electric telfer with a crane unloader and movable loops.

evident that in the minds of the general public and many officials there is no clear differentiation between the function and physical characteristics of the industrial and the commercial port.

The city of Newark has been working toward the development of the Port of Newark.[1] Work has been commenced on the project of reclaiming 260 acres of land. Twelve to fifteen millions of dollars are being expended. The Government has been persuaded to dredge a channel 20 feet deep and 400 feet wide. The plans call for the construction of piers 1,200 feet long on an area which lends itself most admirably to the roomy quay development. The idea is to make a seaport of Newark. Newark's future does not lie in the fact that there is berthing space for seagoing ships at Newark. There is an immeasurably rich future for Newark if it drops the commercial seaport idea and bends all its energies to building an industrial port where industries may have rail delivery to and from all the railroads, and above all easy lighterage and barge connection with the great commercial port of New York and its tremendous inland waterway system which is now nearing completion. The liner traffic wants to be as close to Fifth Avenue and 42nd Street as possible and will not go to Newark. Tramps will go on charter. But if it is developed as an industrial port, lighters would put every factory in Newark Bay alongside every ocean ship in New York Bay.

Jamaica Bay is more promising as a commercial seaport. Yet here too the real future lies in developing industrial areas with water and rail connection. It is most discouraging to find projects for Jamaica Bay improvements with the land all filled in to a regular straight bulk head line, and plans for literally hundreds of long narrow piers like centipede legs extending at right angles into the fairway. It seems incredible that anyone could dream of perpetuating the faults of New York's peculiar inherited conditions, that he should want to continue the congestion and inefficiency of the narrow uncorrelated piers which are New York's sorrow. There is such an expanse of possibilities at Jamaica Bay that the area should be reserved for the time when the Port of New York can no longer accommodate overseas liner business. This area destined for a future commercial port should not be built upon now or otherwise improved as there may be many different needs to be met in the deep seaport of 25 or 50 years hence. This criticism, with that which follows, is not meant to be carping, but is offered in the hope that it may be constructive.

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[1] *Engineering Record*, August 14, 1915, p. 201.

A daydream illustration of a future Mill Basin is most discouraging. The larger part of Jamaica Bay is the hope of the future of manufacturing Greater New York. The effectiveness of the area in reducing the cost of transportation and therefore eventually the price of the products, not to mention the social benefits of garden cities like Port Sunlight in England, depends on the ability to move freight by water between Mill Basin and the city of liners in New York Bay. This can be done only when every factory site is assured of lighter connection at least. It is hardly possible to have all sites supplied with deep water to load ocean steamers. Yet all factory sites may be so laid out that every factory or loft building can have lighter connection with the whole of the water area of the Port of New York. This is the great *raison d'ètre* of the Mill Basin improvement, and the possibilities are not understood, or for sake of immediate profits are ignored. To be given an area of this size, quality, and dredging conditions and then build it up solid with no water connection and with congested narrow piers is indeed to be like the Muckraker in Pilgrim's Progress who saw not the shining crown above his head.

The lighter is the greatest asset for inner harbor traffic in a port with the area of the New York and New Jersey waters. Not to plan to use it for every possible purpose, except railroad freight which should move by car, is indeed to fail to see the shining crown of unlimited economies and industrial growth. The Greater City must see the crown and plan for the future accordingly, at Jamaica Bay and elsewhere.

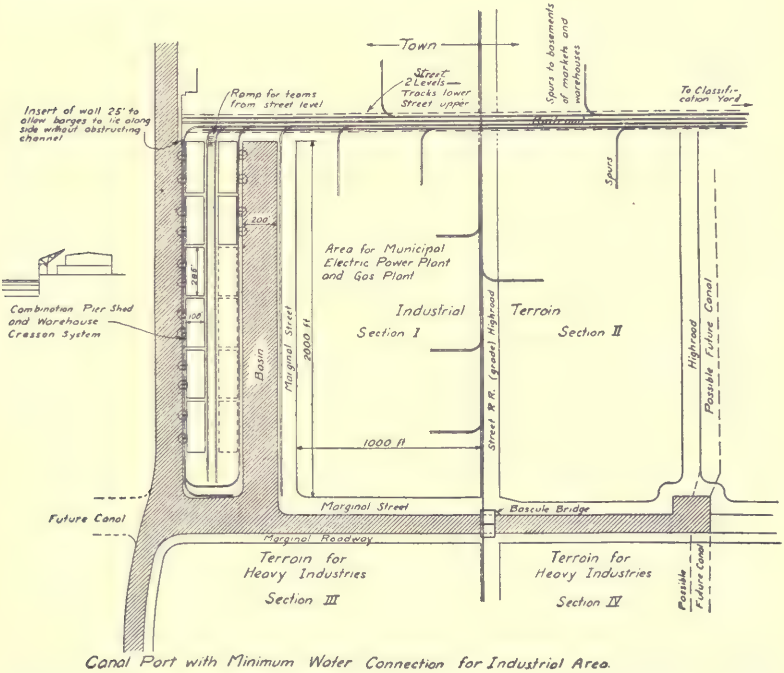
At present, under the existing rate structure the two great projects are hopelessly handicapped because they are outside of the "free lighterage" limits. The same applies to Yonkers.

A Model Inland Commercial and Industrial Port.—At the large river or canal town how should an industrial harbor be laid out? The accompanying plan will indicate the general principles to be followed.

The canal or river waterfront in the vicinity of the town should be reserved for regular commercial shipping facilities. The wharf is set back from the canal shore line to allow barges to lie alongside without narrowing or obstructing the channel of the canal (Fig. 114).

The usual quay equipment with cranes, sheds, car tracks, team road, etc., is necessary. Cranes are indispensable as barges have no tackle of their own for loading and unloading.

To allow for the future growth of the river port a basin, 325 feet inshore from the first wharf line, should be provided. It will be necessary to build this side-arm basin with its retaining walls. As the need arises with the growth of the city's commerce, the sheds, cranes, and tracks can be added.


Town
Street
2 Levels
Tracks lower
Street upper
Spurs to basements of markets and warehouses
To Classification Yard
Ramp for teams from street level
Insert of wall 25' to allow barges to lie along side without obstructing channel
Railroad
Spurs
200'
Area for Municipal Electric Power Plant and Gas Plant
285'
100'
Combination Pier Shed and Warehouse Cresson System
Industrial
Terrain
Section I
Section II
Basin
Marginal Street
2000 ft
Street R.R. (grade) Highroad
Highroad
Possible Future Canal
1000 ft
Future Canal
Marginal Street
Bascule Bridge
Marginal Roadway
Terrain for Heavy Industries
Section III
Terrain for Heavy Industries
Section IV
Possible Future Canal

Canal Port with Minimum Water Connection for Industrial Area.

FIG. 114.—An inland commercial port with industrial area. A suggested model layout.

The side canal and basin entrance should not be at right angles to the canal, but at an inclination, in the direction from which the largest volume of freight is expected. In the case of the barge canal it would be towards Buffalo. In the case of a river port the inclination of the entrance should be down stream. Boats should swerve into the basin while head on against the current.

The industrial terrain should extend upland from the basin and from the side-arm canal. At points beyond the commercial harbor, away from the town, where land is less valuable, the industrial area may extend to the main canal. An occasional transverse or side-arm canal, if the character of the soil allows its excavation, will open additional valuable areas.

If these side canals are numerous there is no reason why the industries which settle there should not extend to the water's edge. If the canals are far apart and expensive, the Harbor Board should provide for a marginal street, but with provisions for the building of conveyors and telphers across the street at sufficient head-room height. The street can always be used as a public landing place in case of need. In fact, it may become an integral part of the commercial basin for many kinds of merchandise without in any way detracting from the accessibility and the value of the industrial area.

The more important industries which need fuel, such as the Municipal Light and Power Company and the Municipal Gas Company, will naturally locate at the end of the basin nearest to the town. Sec. I and Sec. II will be devoted to the more intensive industries. The heavy industries will locate in Sec. III and Sec. IV.

Harbor Street should be double-decked to allow the free movement of cars on the lower level. These tracks afford sidings to connect with the wharves and the industries, and toward the town side allow basement delivery by spur tracks to manufacturing loft buildings, warehouses, wholesalers, etc.

The classification yards should be located upland from the canal and harbor district. By no means should railroad yards be allowed to occupy commercial or industrial waterfront property. This has been the greatest sin of our fathers in the United States, and we, the present and the coming generations must pay the penalty. The classification yard for C. L. and L. C. L. freight is as necessary to a port as the piers or wharves, but that is no excuse for putting the yards where the piers should be.

As the industrial district extends along the water highroad, at as great a depth as the mechanical devices and ingenuity of engineers and economists can make it, but always away from town, there arises the necessity of housing the people who are engaged in the industries. The necessity of the housing problem should not be an excuse for making the new sections ugly. Utility is no excuse for bad taste. As the industrial area extends along the canal and not to a great depth from the waterfront, there should be the same natural tendency to expand on the part of the living quarters. The opportunity of creating garden cities of the "Port Sunlight" variety is exceptionally obvious when the main bread-winning district of the community is not scattered to the four corners nor concentrated into town slums, but extends in a long-drawn-out series of industrial plants. The workingmen's garden villages should be the logical method of housing the industrial population.

Along the highroad at the rear of the industrial cities run spur tracks from the belt railway. The road must be wide enough to accommodate them. On the other side of the road run the street car lines which connect the industries with the town. It is very important to the town which has gone to the expense of laying out all this that the men with the pay envelopes of the industries find it convenient to get to town. There is no difficulty in laying railway tracks along one side of the road and street car tracks along the other side with a railing between them and the main thoroughfare, because there are few occasions to drive up to a curb on such a highroad. It is evident that the street will be lined by high walls or fences separating the various plants from the street. The only crossovers necessary are at the gates of the various plants. Here the gateman, whom every plant must keep, is flagman whenever cars or drays must enter the gate.

It has not been possible to do more here than indicate the nature of the problem of inland navigation as a means of aiding the railroads, promoting national production, and increasing the efficiency of those seaports which are located at the entry of the sea for the hinterland served by such waterways.

CHAPTER XVII

THE FREE PORT AS AN INSTITUTION

The modern free port is an area of a port separated from the customs area of a nation by a stockade. Ships may enter such a port, discharge, load, and depart without customs formalities. The goods may be stored, repacked, manufactured, and re-exported without customs formalities. Only when the goods pass the barrier to reach the consuming public of the country do they undergo customs revision and pay the necessary duty. A free port is a "Custom's Outland" within the political boundary of a country.

It will thus be seen that there is a distinction between a free port and a free-trade port. A free port may be located in a country which is otherwise protectionist. It is then a sort of isolated partially free-trade area within the political area of a tariff-protected country. For instance, Hamburg is a real free port; it is situated in Germany, which is a protectionist country, but nevertheless goods which are dutiable in Germany may be imported duty-free into the free zone at Hamburg. Hong-Kong, on the other hand, which is often quoted as an example of a free port, is in reality a free-trade port. It is a port in a free-trade British colony and in addition is separated from the mainland of China by the natural barier of the sea. Goods may be brought to Hong-Kong, stored, resold, repacked or handled in any manner, and then reshipped. But this is not because any specific law has been passed decreeing Hong-Kong a free port. It is a free port *de facto,* but not *de jure,* as our legal friends would say. It is not therefore a free port within the meaning of the discussion.

Any attempt to confuse the question of free ports and the question of protectionism versus free trade is therefore based on a misconception of the real nature of a free port. However, it is true that throughout history, until 1888, the free ports of the world have been the ports of the free-trade countries. Until that time there was no evidence of a desire on the part of the Governments to charge more than a nominal rate on imports, for they were interested in aiding commerce and not in hindering it for the sake of home industry.

Since that date, the modern free port has been in fact, as well as in origin, the result of a compromise between the legitimate claims of free trade and of protection. Unlike most compromises, however, this one has worked well in practice.

The following quotation from a speech by H. R. Geddes, on "Free Ports in the United Kingdom," at Dover, Feb., 1918, follows:

> "I have succeeded in obtaining a Parliamentary Return specifying Ports of the Continent which are Free Ports and giving information respecting them. This report, unfortunately, is rather old, being dated 11th August, 1904, and I am sorry to have no more up-to-date information which, had I been able to obtain, would, I feel confident, have strengthened my case materially. At the date in question the German Empire had nine duty Free Areas, varying in size from the Free Port of Hamburg, with an extent of about 2,500 acres, to the Free District of Danzig, with an extent of less than an acre. Austria-Hungary had two, Denmark and Rumania had one each. In nearly all cases the Free Port is geographically a part of a larger Port area, although for statistical purposes the Free Port is usually treated as a distinct locality. The Free Ports in the German Empire are Hamburg, Bremerhaven, Cuxhaven, and Geestemunde. There are also the Free Districts of Bremen, Emden, Stettin, Brake and Danzig. The Free Ports of Austria-Hungary are Trieste and Fiume. The Danish Free Port is Copenhagen, while Rumania's is Sulina."

Consignment and Re-export.—The prime interest in a free port centers in the question of a consignment market and re-exportation.

Famous commercial powers of history have waxed rich on the re-export and transshipment business, such as Tyre, Carthage, Byzantium, Venice, Bruges, and the Hansa Towns. With the beginning of the Colonial Era, Lisbon became the great distributing center of the world. In the sixteenth and seventeenth centuries European ports obtained their oversea wares from the Dutch. The great ships brought the products of all the known world to Amsterdam to be warehoused and re-distributed to the minor parts of Europe. This carrying and distributing trade made Amsterdam the center of banking, commerce, and shipping. The great mercantilist Colbert stated that out of a total world's tonnage of 20,000 merchant ships in his time, 16,000 were under the Dutch flag.

Cromwell recognized that the wealth of the Dutch, and to a less degree, but in like manner, the wealth of Hamburg and Bremen, had its source in the distributing and carrying business. Cromwell's Navigation Act of 1651 therefore struck a blow at this immensely profitable service, by prohibiting goods to be brought to England except in ships of the same nationality as that of the origin of the goods. The Navigation Act terminated the enormously profitable entrepôt business of these small, but rich, shipping centers. They were not producers, but carriers, warehouses, and distributers.

When London drew the transshipping business from the North Sea states, it became the banking and insurance center. The most important free port of the world was London. To London the great convoyed fleets of merchantmen brought fleet-loads of spices, coffee, sugar, tobacco, and treasure. To London came the many little North Sea, Baltic, and coastwise vessels to take away the needed supplies for their local markets. London became great commercially in large measure because, like its predecessors, Amsterdam, Antwerp, and Bruges, it was a cargo clearing house for the reception, division, storage, and transshipment of fleet-loads of wares from all the world.

London has grown to be the world's chief consignment market. Raw materials for manufacture or consumption, harvested throughout the world, but as yet unsold, are shipped to London to be warehoused until the consumers of the world are ready to buy them. The shippers are credited with 70% to 80% of the current value of the wares and the banks finance the transaction. When the stocks of goods are gradually sold, during the time between harvests, the other 20% or 25%, less interest and commission, are realized. The consignment market is possible because of the ease of importing, storing, and re-exporting at that place, in conjunction with banking facilities, shipping service, etc., one reacting upon and animating the other.

A few figures will illustrate the importance of this re-export system in the commercial life of Great Britain. In 1913 the United States, the greatest producer of many kinds of manufacturing, imported from England over $289,000,000 worth of materials. Of this amount, $147,000,000, or more than half, consisted of goods which are not produced in England at all.

For instance, we imported from London $40,000,000 worth of rubber from Brazil, the Congo, and the Straits; $30,000,000 of cotton, mostly Egyptian; $25,000,000 of block tin, largely from Bolivia; $10,000,000 of Australian wool; and $700,000 of Philippine hemp. Obviously this means that as far as the United States was concerned, over half of the imports from England were not produced in England, but were re-exported from England for the greater glory of British shipping and banking, having been first sent to England from some other country where they had been produced. This is what we mean when we say that London is now the greatest consignment market in the world. In the first six months of 1917 75% of the imports from England to the United States were from other than English sources.

There is reason to believe that New York should become another such consignment port as London, provided that the same facilities for financing, insuring, and free movement be established here.

Under a free zone system such as that here outlined, New York and other American ports might be made the greatest consignment and re-shipment ports of the world, New York should become a second London as a consignment market. The war has given a great impetus to the practice of shipping goods to New York and then re-shipping from New York to the final destination. The interruption of direct communication between ports of South America, Australia, Malaysia, Asia, and the usual ports of shipment in Europe, has caused a great increase in the amount of re-shipping done in New York.

Before the war we had done very little re-exporting, on an average about $40,000,000 worth a year, or 2% of our total exports. Great Britain, on the other hand, had done a re-exporting business amounting to over $500,000,000 in the same time. Since the beginning of the war, however, our re-export business has advanced with great strides, almost doubling in three years. In 1913, the year before the war, our re-exports totaled $35,000,000. In 1916 they amounted to $61,000,000, which sum does not include merchandise which merely passed through our ports in transit.

By far the greater part of the total imports of the United States come through New York. This point may be substantiated by figures for the different kinds of imports. As to rubber, for instance, from January to May, inclusive, of 1917, New York imported about 57,000 tons, while all the other ports of the United States put together received only 19,000 tons; in other words, New York imported 75% of the total. In regard to coffee imports, too, to mention only one other of the articles which are imported in large quantities, New York is the supreme importer of the nation. Authorities on the subject state that the coffee trade at New York has grown so that it is far in excess of the facilities for handling. Its imports for the year 1916 amounted to over $100,000,000. In one month it had on hand a supply of over 600,000 bags of coffee, when the total monthly imports for the whole United States were about 750,000 bags. This will illustrate the magnitude of the import business of New York and the great field for the improvement which the free-port system brings.

In the case of the rapid growth of Hamburg during the twenty-five years prior to 1914, the volume of business of the port is not to be attributed to the comparatively small German Empire and part of Bohemia as a hinterland, but to the re-export business to Scandinavia and Russia, to Holland, and to the rest of Europe. When the statistics show that before the war Russia bought 52% of all her imports from Germany, it is to be borne in mind that much of this was American goods warehoused in the Free Port of Hamburg and re-shipped, as sold, to Libau, Riga, Helsingfors, or Reval by small Baltic steamers. This 52% credited to Germany included American products from Quaker Oats and Remington Typewriters to Yale Locks and Steinway Pianos. This immensely profitable business would have been very difficult and in many cases even impossible without the institution of the free port with its equipment for handling and warehousing cargo, and freedom of re-shipment.

The Free Port and the Load Factor.—The institution of the free port has its economic corner stone in the load factor. The large ship is more economical than the small one. The trouble is to find cargo for her. Also the more ships come to a port, the better the service, the more animated the business of the port, the greater the possibility of filling the large and economical freight liner. This type of ship gives better service, sails oftener and faster, and generally stimulates business. On the other hand few consumer communities absorb commodities in shipload lots. A family knows that it can buy veal cheaper per pound by buying a whole calf, but the average family can not use a whole calf. Certain countries may fill a ship with coffee, as Brazil, or with sugar, as Java or Cuba, or with steel rails or harvesters, as the United States, but few markets can absorb such shipments with regularity. The way to secure low freight rates and frequent express service overseas is to be able to unload cargo lots at the warehouses of a great port from which small short-haul feeder liners distribute the commodities to the secondary markets. In the past the United States has absorbed cargo lots within its own borders and has therefore had little re-export complications. However, in the future, with the smaller South American markets opened to the United States, it will be good business if many products, now handled uneconomically in broken lots, if at all, be consigned to an American free port in cargo lots for feeder-line distribution to the smaller markets of Mexico, and Central and South America. After the war, with a shortage of tonnage and an increase in the size of the ships of new construction, very few ports will be able to afford direct connection to any but the large world's markets and the smaller markets will not be able to support direct line service at all. It will therefore be necessary after the war to develop the feeder line system to an extent not known before.

A corner stone of English shipping supremacy was the London consignment market. German rivalry was due largely to the free ports of the Hansa Towns. The free port may well become the corner stone of American shipping supremacy after the war.

The Consignment Market and Local Industries.—One advantage of having a great consignment market is that, since large quantities of raw materials are constantly being imported at first hand from the countries where they are produced, industries for many miles around are stimulated, because they can obtain their necessary raw materials cheaper. Furthermore, since large quantities of material of every kind are constantly being brought together from all sources of supply, the product will be better graded and a wider range of prices between grades will be secured. The manufacturer will have an opportunity to utilize different grades of raw material for different grades of the finished product, and even for different kinds of finished products. This means the cheapening of the whole scale of prices for a certain product, the supplying of a wider range of qualities of the same product, and the consequent opening of new fields of consumption, with a resulting quickening of industry and finance. In fact, the ramifications of the increased activity of business caused by the free-port system are very far reaching.

Another advantage is the increased import commerce that comes to any port that has large stocks of any raw material, and the proper facilities for its physical handling and financing. For instance, hides and leather are on the free list, that is, any one who imports them into New York harbor does not have to pay any duties on them. Accordingly the import business of New York in sending leather to the tanneries of Newark and the shoe factories of Connecticut and New England has been increasing amazingly in the last few years. This illustrates, too, how conversely, manufacturing is aided by the increase in imports.

The Free Port and Bonded Warehouses.—The existing practice of storing imported goods in bonded warehouses pending further disposition is hardly different in principle from the free port. The object of the bonded warehouses is to facilitate re-export and to relieve the merchant from the financial burden of laying out large amounts of his operating capital in duties before the goods are sold. The advantage of the bonded warehouse is constantly employed by importers, whose bonded merchandise amounts to huge sums. The value of the bonded merchandise reported on September 1st, 1917, at New York was $63,322,000. On August 1st, it was almost $60,000,000 and on September 1st, 1916, $82,000,000.

The following table gives a comparison of 32 important articles, showing the stocks in bonded warehouses at the beginning of September, 1917; August, 1917, and September, 1916.

The bonded warehouse is a little free zone. The trouble is in the formalities of bonding and taking out of bond and the lack of flexibility. Goods in scattered bonded warehouses are carefully hedged about. By liberating the methods of bonding and then placing all of the bonded warehouses together for easy supervision, the equivalent of the free zone will be attained. The degree to which such a bonded warehouse zone will approximate a free port will depend entirely upon the success of legislation to reduce the present formalities and "barbed wire" to a minimum. If the sound of the name "free port" is offensive to protectionist ears the words "bonded warehouse zone" would cover the situation exactly. The full benefits of the free zone would be accomplished by concentrating all bonded warehouses within a stockade and then reducing the regulations to the most simple form.

	Sept. 1, 1917	Aug. 1, 1917	Sept. 1, 1916
Bristles	$255,339	$192,731	$584,403
Coal tar colors	70,714	79,051	302,442
Stockings, hose and half hose	194,062	194,163	216,109
Cotton, laces	10,988	16,870	136,177
Cotton, other manufacturing	546,117	539,754	418,425
Gloves, kid, etc	533,335	541,246	527,373
Silk clothing	245,352	236,072	430,761
Cork manufacturing	300,343	304,867	393,564
Cotton clothing all other	259,569	259,427	255,743
Linens	1,206,852	1,153,175	2,583,149
Yarns and threads	27,113	24,272	28,857
Furs, dressed, skins	101,108	132,203	302,328
Hat materials	395,085	285,063	319,447
Hats, bonnets & hoods	826,354	831,583	1,006,222
Tobacco			
For wrappers	6,445,999	6,128,409	7,142,866
All other leaf	9,877,075	9,173,094	13,316,231
Champagne	1,074,124	1,192,163	1,642,873
C. sugar n.e.s	10,172,756	868,116	19,329,599
Wool, other manufacturing	443,197	444,214	464,020
Wool clothing	230,247	231,870	269,476
Wool cloths	1,107,553	1,115,806	1,242,067
Wool dress goods	375,717	371,391	434,072
Antimony	856,780	557,357	1,670,550
China, decorated	12,440	5,836	14,782
Acids all other	150,322	119,262	58,953
Gum chicle	268,389	326,784	649,454
Plushes, velvets, etc	194,062	148,599	229,664
Forgings, anti-friction ball bearings	2,046	2,046	109,203
Cutlery	2,920	2,920	2,598
Olive oil	427,610	449,807	525,602
Perfumery	310,619	334,972	227,967
Opium containing 9% morphine or over	237,535	233,808	218,455
Total dutiable	$56,567,147	$53,484,075	$76,509,462
Total free of duty	6,755,516	6,463,348	5,524,285
Grand total	$63,322,663	$59,947,373	$82,033,747[1]

In the recent discussion of the free port it has become apparent that the chief opponents of the free-port idea are the New York warehouse companies. The reason probably is the apprehension that a free port would mean a considerable reorganization of the port's storage business. No one cares for innovations in one's own business brought about from outside. However, judging from the past experience of European ports adopting the free-port system, the warehouse companies would ultimately benefit by a free port through the stimulus it would give domestic trade. There would be an ever increasing need for warehousing aside from the placing of goods in bond which would more than make up for this item. In fact the privileged free-zone warehouse companies of European free ports are composed of the several leading warehouse companies which continue their old domestic warehouses and also participate in the new institution.

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[1] *Journal of Commerce*, Sat., Nov. 10, 1917.

Even when goods are on the free list the formalities of clearing them through the customs are the same as when there is a duty to be paid. This would always be so on leaving the free zone, but the entry into the free zone would be free from any such delays for free and dutiable goods alike.

Drawbacks, Manufacturing in Bond and in the Free Port.—The anticipation that a great manufacturing district would grow up within the boundaries of the free port has not been realized at Hamburg except for certain commodities. There are many rice mills, coffee roasters and mixers, tea blenders, some oil refineries, and a few other industries which have found location in a free zone an advantage. The storing and cutting of foreign wines has been one.

The fact that many of the raw materials which are most used in American industry have been put on the free list has sometimes been brought forward as an argument to prove that it is unnecessary to institute a free-port system. Of course no one would make free raw materials into dutiable finished product in a free zone. The major part of the manufactured articles of any country are dependent on the home market. That means that they would have to pay duty as soon as they were taken outside of the free zone limits for domestic consumption.

It is evident that profitable manufacturing in a free port would only occur in case of articles destined for export having the major part of the materials entering into the product imported from abroad and subject to duty. Materials on the free list would not find any particular advantage in free-port manufacturing. However, with many articles not on the free list and no assurance that a change of administration will not alter many articles on present free lists to dutiable goods, there is still an advantage to the free port of no small importance to our export trade.

Shipbuilding is the most important free-port industry. At the free port of Hamburg, for instance, there are 17 shipyards. A ship must be a free trade product even in a protectionist country. To face the competition of free-trade built ships it is necessary to build ships under free-trade conditions. If the ships are built in a free port, the whole world lies open for the purchase of supplies from the cheapest market. Hence the institution of the free-port system in America would greatly promote the development of the shipbuilding industry. Other examples which follow will further illustrate the obvious truth that the degree of advantage offered by the right to manufacture in a free zone will depend entirely upon the nature of each business under consideration.

Duty, Drawbacks.—One method employed at present to accomplish part of the same work as the free port is that of drawbacks, whereby a duty is charged on an article which comes into the country, but 90% of the amount is refunded if the importer or manufacturer re-exports it. The drawbacks on raw sugar imported to be refined in the United States and re-exported as a finished product amounted to $19,000,000 in 1916. This single item, one of the largest, serves to show the extent and volume of drawbacks even under the present rigid system. The manufacturer can recover his drawback only under certain restrictions, chief among which is the provision that he must be able to identify his product as the material which he has imported, that is, he must not change its qualities too much in the process of manufacture. The exacting regulations of the drawback procedure may make the manufacturer liable to prosecution for defrauding the government even without intent.

An illustration of the injustice which this system works was given at a recent hearing by a manufacturer of candied dates, who does a large foreign business. He had tried to get a drawback on the dates and the sugar which he used in making up his product. His request was denied on the ground that the materials used had been changed so extensively in the process of manufacture that they were no longer recognizable, and hence were not entitled to the drawback.

Other objections to the drawback system are the great delay involved, during which a certain amount of capital is tied up and is unavailable for carrying on the business, the immense amount of red tape which must be gone through, and finally the fact that the drawback, when recovered, does not amount to the full sum paid as duty to the Government. For these reasons, a number of firms, which by the provisions of the law are entitled to receive a drawback, do not apply for them unless the duties paid have been very high.

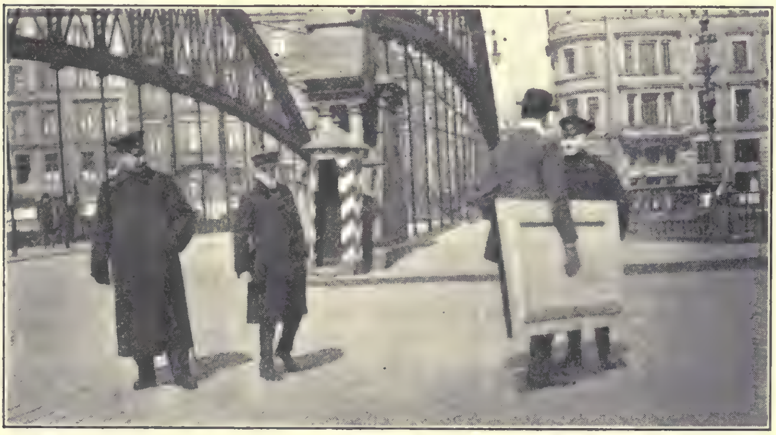
Manufacturing in Bond.—Another plan now in operation to serve the purpose of the free zone is that of manufacturing in bond. In the case of tobacco imported in bond a law written into the Tariff Act permits the manufacture of cigars from Cuban tobacco in Florida bonded warehouses. Upon compliance with prescribed formalities, manufacturing in certain bonded warehouses is permitted without payment of duty on the raw material used. This system has its merits, and is not inconsistent with the establishment of a free-port system. In fact, the bonded factory under this plan, like the bonded warehouse, is a little free port. The only objection to it, but that a weighty one, is that there is so much official formality and inconvenience to go through and so much valuable time is lost, that many of its advantages are thereby neutralized.

Other Considerations.—It must not be overlooked, also, that the importance of any free zone will lie in the shipping lines connected with it. A free zone may add new lines, but it is not a thing in itself which will revolutionize the existing trade routes of the world. The amount of advantage which the introduction of the free port system will bring to any port must be studied separately for each port according to its peculiarities.

Warrant or Lombard warehouses where goods may be stored and negotiable warehouse receipts issued on them are a necessary part of the equipment of a free port. The transaction is the hypothecation of property rights to the goods as security for a loan from the bank. American banks will have to develop a high degree of coöperation with the business man if a really great consignment market is to be developed, and security will have to be provided against fire, theft, and fraud. The ease with which consignments are financed is one of London's chief advantages.

It has been suggested for American ports that the customs lines around a free port should be extended to include all the factories and warehouses near the harbor. This idea is not practicable, because it would make the cost and difficulty of guarding the stockaded district which comprises the free zone too great. For this reason the area to be included within the stockade should not be made too extensive. Supervision and inspection costs to the Government should be decreased rather than increased by the institution.

The idea of levying duties on commodities consumed within the confines of the free port is impracticable of execution and at variance with the very idea of the free port. It is of prime importance that the free-port zone should not be a place of habitation. The only persons who should be permitted to live within the zone are government employees duly sworn in as inspectors or watchmen, who should be under bond for the actions of their families. Their habitations should be built as part of the port equipment. Aside from such authorized persons no one should be allowed continued habitation within the zone except crews on board ship.



(Photo by author)

Fig. 115.—At Hamburg. Customs inspectors stop everyone coming from the free zone at the bridge leading across the canal which separates the free port from the customs area.

To provide for the many thousands of persons employed in the free port during the day, Hamburg has licensed the Peoples' Coffee Halls, a philanthropic society, which maintains soup kitchens and rest rooms for the comfort and convenience of such persons. From 20,000 to 30,000 people enter the free port every day and leave it again. They pass inspectors coming out and must show the contents of all packages.

Under a free-port system the customs officials will be relieved of one objectionable feature, the irregularity of their work. At the present time, days of idleness alternate with days of overwork when several large ships arrive together. In a free port there is no such fluctuation because the free port acts as a reservoir from which goods liable to duty move in a fairly constant stream. It is thus possible to equalize the work of the customs inspectors at a free port.

With the large capital investment which a modern ship represents, the speed of discharging and loading is an important factor. A great saving in this respect is effected when the free-port system is instituted. At an ordinary customs port, the formalities of getting out permits to unload require about 24 hours. Of course, it is possible to save some of this time by getting the permits in advance, but this is not always practicable, and the time, trouble and delay are always present in a varying degree.

In a free zone all this is saved. The pilot is a customs official and flies the customs flag. He brings the ship directly to its berth without delay, and sees to it that nothing leaves the ship outside of the free zone. Flying the customs flag the ship may at once proceed to the confines of the free port and as soon as it is berthed may begin to discharge its cargo at any time of day or night. The fact that only a small part of the cargo is moved to the interior on its arrival, and therefore needs inspection and appraisal by the customs officials, tends to decrease the congestion and delay on the wharves. Much of the cargo moves rapidly to the free-port warehouses, to the freight cars, and to the classification yards within the free zone. There is no delay in berthing or discharging at the ships' side.

The location of the free port is a question which will call forth much competitive effort among all the ports of the country. If any Government money is to be spent, every river and seaport, town and district in the whole United States will suddenly discover that the Government will be making a great mistake if it does not establish a free port in that particular place. The German imperial government aided Hamburg and Bremen by a contribution to the costs of construction amounting to about one-third of the outlay. Its attitude has always been that the chief advantages were local and should be paid for out of local treasuries. The American Government will probably find on investigation that there is a sound economic foundation in the free-zone principle and that certain American ports will be benefitted by such an institution. If the Government passes an enabling act which will permit any American port, city, or state to erect a free zone according to well-defined conditions and limitations, a great step forward will have been taken. Each community will then decide for itself, after thorough investigation, if the innovation is worth the price.

As to the design of the port, there are no ironclad rules that can be laid down. The laws which we have been trying to enunciate in the above chapters for the well-designed port will apply in exactly the same way whether the port has a customs stockade around it or not. There may be an exception to the above rules in regard to storage space required. A free-port consignment market would mean an increase in the ratio of warehouse space to total tonnage. It is doubtful whether warehouse space of 1½ times the total tonnage capacity of all the berths will be sufficient. In the case of coffee warehouses there should probably be twice that amount.

It is also not essential to have only one zone at a port. In a harbor as large as that of New York or Boston, with many parts of the harbor which are widely separated, it will doubtless be necessary to have more than one zone. It is always possible, with but slight expense, to have lighters, barges, or ships to move from one part to another under customs supervision. A customs flag and sworn deputies will accomplish ample security.

Commercial Advantage to the Free-port City.—An instance of the stimulus of the free-port system to the growth and prosperity of a city is Hamburg. It is not claimed that the free port was the sole factor, yet its contribution is a large element. The increase in wealth and population in the 25 years before the outbreak of the great war was phenomenal. In that time it increased its population from 300,000 to 1,300,000 more than 400%, while Germany as a whole increased its population from 48,000,000 to 68,000,000, or 41.6%.

This immense and profitable business would have been difficult and perhaps even impossible to transact without the institution of the free port and the consequent large facilities for handling and warehousing goods and providing for their re-shipment. As a result of this immense volume of re-export business, Hamburg, before August 1st, 1914, was second only to New York in the amount of business transacted. It had an annual amount of $1,960,000,000, while New York had $1,966,000,000, retaining its supremacy by the narrow margin of $6,000,000, a margin narrow indeed considering its tremendous superiority in population and size. More than that, the average per capita wealth of Hamburg is 60% higher than the average per capita wealth of the rest of the German Empire. The income of the port from tonnage fees increased from 1,000,000 Marks in 1889 to 4,400,000 Marks in 1913, while the sums devoted to its maintenance are only 4% to 5% of the total budget of the Port of Hamburg.

A tool of commerce with such possibilities of development should not be allowed to pass uninvestigated at this time, when the competition for the overseas markets after the war will be keener than ever before, and foreign markets of far more importance to the United States than at any time in our history, to save our war-stimulated industries from collapse by securing markets to absorb the products of peace.

CHAPTER XVIII

THE PROCESSES BY WHICH THE FREE PORTS OF HAMBURG AND BREMEN WERE CREATED

The present agitation for free ports in the United States has led to a careful study of existing free ports abroad. As the sources of definite information are difficult of access, it will be well worth our while to turn aside, for a chapter, and study in detail the process by which the most conspicuous examples of free ports, Hamburg and Bremen, came to be established. As we look forward to legislation in the United States to permit the institution of a similar system here, we may find some instructive points in the experience of the two noted examples which we have mentioned.

Hamburg and Bremen are so similar in history and political institutions that we will need to consider only the larger of the two, Hamburg, in order to understand the situation of both. As a matter of fact, when the question of incorporation into the customs union of the German Empire came up, Bremen followed the practice and methods of Hamburg in establishing the free zones as they are known to-day.

Before we can understand the present situation in Hamburg we shall have to consider the peculiar history and political institutions of that state. The Free and Hanseatic City of Hamburg is now, and has been since 1871, an independent federal state of the German Empire, an *imperium in imperio.* It was founded in 871 and granted extensive privileges by Frederick Barbarossa in 1189. In 1292 it received its independence and its first constitution, which has been the Magna Charta of all its constitutional changes ever since.

Under the form of government then established the ruling power was in the hands of a Senate of 18 to 24 members at different times in its history. These *consules* or Senators were chosen from the merchant's guild. From its first constitution, the government of Hamburg has always been a government by merchants, which is as it should be, since Hamburg's one and only interest of importance has been and still is her shipping and commerce. The leaders of the Senate were four *proconsules magistrii civium.* All the members of the Senate together form a sort of corporate sovereign, who is the ruler of the State of Hamburg.

This supreme power of the Senate was contested successfully on several occasions by the burgers, who extorted new constitutions which gave the people more power in 1410, 1458, 1483, 1529, 1603, 1617, and particularly one in 1712. The constitution now in force was adopted in 1860, more than a decade before the formation of the German Empire. According to this constitution, the Senate consists of 18 Senators. Of these, only nine may be lawyers; seven must be merchants, and the other two may be of any other profession. Senators are chosen by both houses of the legislative body for life. The lower house, the Burgerschaft, consisted of all the householders until 1860. Since then it consists of 160 representatives, elected by a system of proportional representation. The Burgerschaft gained control of the purse strings in 1563, and now all measures involving the expenditure of money must pass through it. Financial matters are taken care of by the Finance Deputation, and commercial affairs by the Commerce Deputation, both of which correspond to our administrative departments.

When the German Empire was founded Hamburg became one of the 26 federal states, and as such, under the constitution, it retained a number of far-reaching residuary rights. All matters of purely local interest are affairs of the Senate and House of Burghers, and not of Berlin. In fact, the Hansa towns maintain a minister at Berlin as if it were a foreign capital.

At this point it will be worth while remarking that the history of Hamburg and Bremen will not afford us any precedent on the question of the legal organization of a free port. For, as we have just indicated, in their case the free port existed before the laws concerning it were passed, and what the laws did was not to create a free port, but to restrict it. In the United States, on the contrary, a free port will not exist unless the Government passes an enabling act permitting the establishment of such institutions. But aside from the bare enabling act, a study of the details of the execution of the plan should be suggestive to us in showing us where we can avoid mistakes and make improvements. For the results which the merchant republic of Hamburg has accomplished in the creation of one of the most efficient ports in the world deserve the attention of Americans. The port of Hamburg, including the channel to the sea, has been bought and paid for by the people of Hamburg and by no one else. It is a harbor of the people, by the people, and for the people, and it has cost the people $125,000,000 out of their own pockets. But in spite of the good work which they have accomplished, we certainly do not intend to rest contented with "just as good," but must go on and build much better than the Burghers and Senates of Hamburg and Bremen.

It is sometimes said that the free ports of Hamburg and Bremen were created by imperial laws. The reverse is much more nearly true. By these laws the free zones or free ports of Hamburg and Bremen were restricted in area, not created. After much bargaining between the Sovereign States of Hamburg and Bremen and the Imperial Government, as represented by the Bundesrat and the Imperial Chancellor, an agreement was reached whereby the customs-free area of the Free City of Hamburg was reduced from 414.5 square kilometers to 10.9, and that of Bremen from 256.4 to 3.3, in so far as the customs of the Empire were concerned. It was just as if Rhode Island, let us say, should have been free trade while the rest of the United States was protectionist; then a law was passed making Newport News alone free trade, while the rest of the state came under the tariff laws. In the same way the two states which by Article 34 of the constitutions of 1868 and 1871 were free trade throughout their entire area had this free area reduced so as to include only certain inclosed zones of the ports.

According to Article 34 of the Constitution of the North German Federation of 1868 and of the Constitution of the German Empire of 1871, the Free and Hanseatic Cities of Hamburg and Bremen remained outside of the Customs Union "until such time as they signify their desire to be included in the Customs Area."[1] Also, such parts of their territory as are by nature not adapted to inclusion within the tariff boundary are not affected by this provision and are incorporated within the Customs inclosure.

The Free and Hanseatic City of Luebeck was accorded the same privilege when the Constitution of 1868 was adopted, but declined to make use of it. It entered the North German Federation and later the German Empire on the same conditions as all the other states except Hamburg and Bremen.

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[1] "Das Verfassungs Recht des Deutschen Reiches," Dr. Ludwig von Roenne, p. 114.

During the ten years following the adoption of the Constitution of 1871 it was found increasingly difficult to guard the customs frontier between Hamburg and the Empire. For instance we find in 1881:

> "1. Anyone having in his possession goods of a nature indicating Hamburg as a source, found near the border between the State of Hamburg and the German Tariff Area will be subject to ten Thalers fine.
>
> 2. Anyone found with dutiable goods in a public house or on the highroad or any other place in the proximity of the frontier between Hamburg and the Customs Area between sunset and sunrise will be detained under suspicion of smuggling."[1]

On December 8, 1881, the Bundesrat decreed that certain islands on the Elbe which belong to the State of Hamburg would be considered as part of the tariff area of the Empire on and after January 1st, 1882. A full and detailed set of regulations was attached, by which it was arranged for ships to proceed up the river Elbe through German Customs Territory to the non-customs territory of the State of Hamburg under a tariff flag by day and certain lights by night.

Some time later the Prussian town of Altona injured the feelings of the House of Burghers and the Senate of Hamburg by asking the Bundesrat, without consulting Hamburg, to include St. Pauli, a suburb of Hamburg, within the Customs Area. This last act accelerated the movement for an understanding between Hamburg and the Empire. Bismarck had repeatedly asked Hamburg when the Senate intended to take advantage of the clause in Article 34, section 1, mentioned above, and "signify its desire to be included in the Customs Union." This suggestion was violently opposed by all the Hanseatics.

As it was evidently necessary to coöperate with the Empire, rather than fight it on the bases of the residuary rights left under Article 34 of the Constitution, the Senate of Hamburg, on March 28, 1881, asked the Burgerschaft to appoint a committee of nine members to confer with a committee from the Senate and representatives from the Treasury Department and others from the Imperial Government to discuss a compromise. The

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[1] "Gesetzensammlung der Freien und Hansastadt Hamburg," Vol. 17, p. 220, date of Oct. 31, 1881.

Burgerschaft was much incensed, but the Senate continued the investigation.

On June 3, 1881, a lengthy agreement between the Senate and the Imperial Government was handed to the Burgerschaft for its affirmation. It covered the general principles and many details for the incorporation of Hamburg in the German Tariff Area and provided for the exclusion from the incorporation of a free harbor zone. This agreement was ratified by the House of Burghers on June 15, 1881. As this agreement between the State of Hamburg and the Bundesrat, representing the Imperial Federation, was accepted by the Bundesrat, it became operative without further legislation. At least there is no law in the Reichs Gesetzblatt, except the one quoted below, which would indicate any further legislation than this agreement.

The history of the case, the agreement with the representatives of the Imperial Government and many communications, including letters from Bismarck, then the Imperial Chancellor, and other exhibits, together with the report of the Senate to the Burgerschaft, are included in the report laid before the Burgerschaft when the agreement was up for ratification. The entire situation is covered in these forty pages of documents which constitute the most important source of material for the free port question.[1]

The agreement concerning the incorporation of Hamburg within the German Tariff Area as presented to the Hamburg House of Burghers, translated, is as follows:

Exhibit 1

Negotiated at Berlin, May 25, 1881, in the Ministry of Finance.

Between the Prussian Minister of Finance, Ritter, and the Imperial State Secretary of Treasury (Reichsschatzamts), Scholz, as representatives of the Imperial Chancellor as participants of the first part, and the Commissioned Representatives of the Senate of the Free and Hanseatic City of Hamburg, Senator Dr. Versmann, Senator O'Swald and the Resident Minister, Dr. Krüger, as party of the second part, have been concluded awaiting the confirmation of the Imperial Chancellor and the Senate of the Free and Hanseatic City of Hamburg, the following conditions of incorporation of Hamburg within the German Customs Area.

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[1] See "Verhandlungen zwischen Senat und Buergerschaft der freien Hansastadt Hamburg fuer das Jahr 1881," pp. 162, 186, 190, 201, and more especially pp. 207–248.

See "Verhandlungen" for 1882 for the plans, maps, specifications, cost estimates, etc., of the actual execution of the work.

See also résumé in MacElwee, "Hamburger Hafenbau Politik."

1

The Free and Hanseatic City of Hamburg is prepared to enter the German Customs Area with all of its territory except the area herein described.

For this area, which Hamburg will retain as a permanent Free Port, Art. 34 of the Imperial Constitution remains in force. The Free Port privileges of this area shall not be either annulled nor abridged without the consent of Hamburg.

The Free Port Area includes..............................

Here follows a detailed description of the boundaries, which are shown on the accompanying maps, Figs. 116 and 117 (also see Fig. 4, page 18)

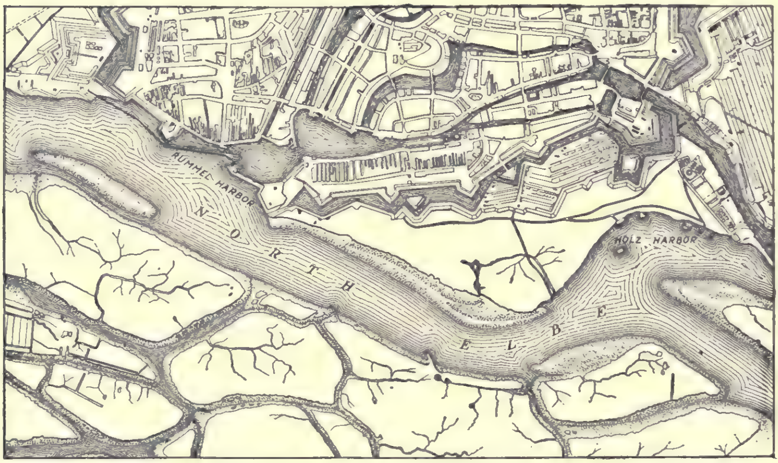

Fig. 116.—Map of Hamburg in 1796. The site of the present free port was a worthless marsh.

The area included in the Free Port on the North bank of the River Elbe shall not be used as a place of habitation or of retail business (except necessary dwellings for warehouse superintendents, customs officers, police officers, and harbor officials).

The area of the Free Port situated on the South side of the river, as far as the same is the property of the State of Hamburg, shall not be built upon for shops or other buildings except to house necessary officials. All existing dwellings and places of retail business, in so far as they do not serve the designated official purpose, shall be removed, as far as

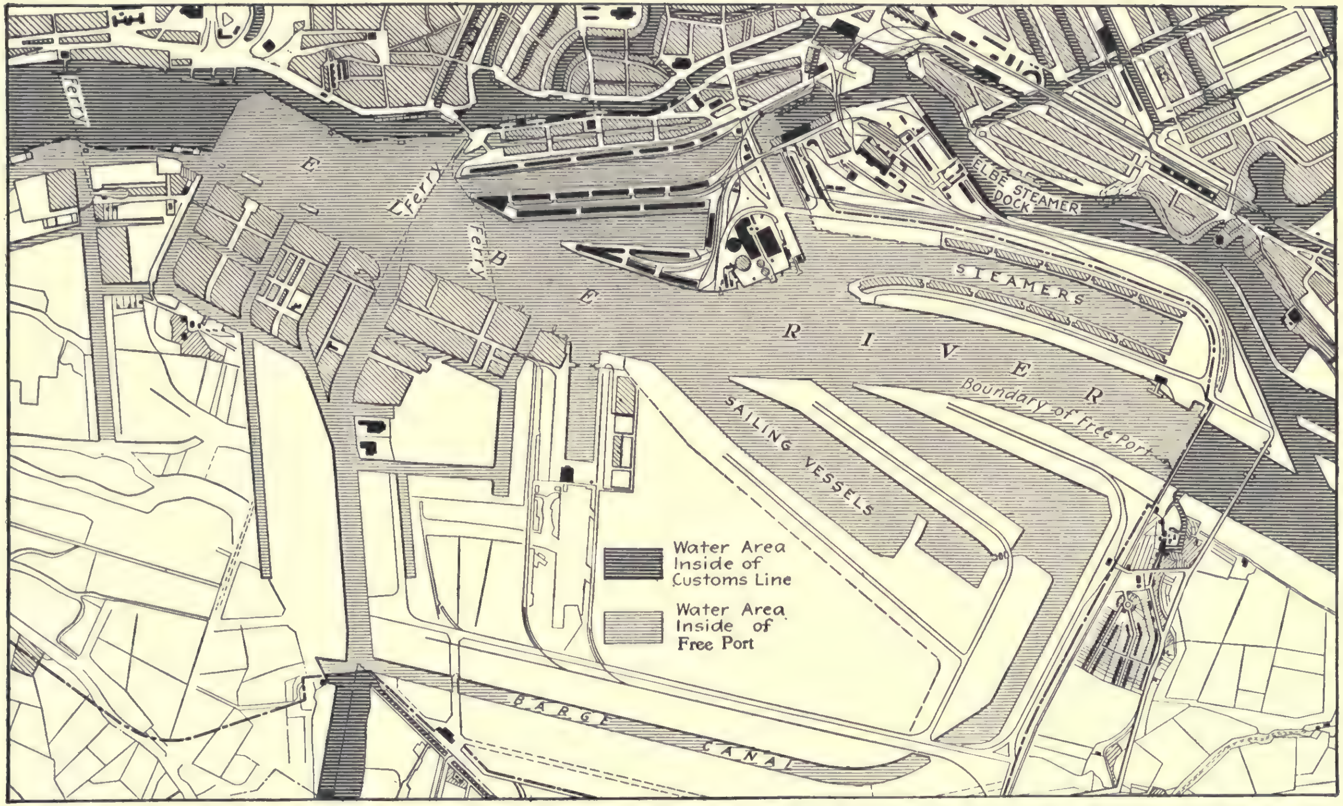

FIG. 117.—Hamburg in 1888 when the free port was opened and the first basins dug on the South Bank. The Free Port Warehouse District is the long cross-hatched group near the north-center of the Free Port area. Notice the canal passing around the Free Port and connecting the upper and lower Elbe without entering the Free Area. The boundary is a high iron fence by land and a floating wooden stockade on the water. Openings in the stockade are guarded by customs officers.

possible. Hamburg will also take all other necessary steps to secure the customs line.

The harbor of Cuxhaven will remain as heretofore, outside of the customs area (*i.e.*, as a Free Port).

The warehouse of the Zoll Verein will be discontinued when the incorporation has been completed.

2

All industries which manufacture for export and are dependent on imported raw materials free of duty are henceforth restricted to the Free Port. Existing establishments of this nature which in the future will be located within the Free Port, but which, because of the extent of the present plants are not able to move at once to the Free Port will be given every opportunity to continue manufacturing under present conditions at the present location until some future time (afterwards this time was set as 1900), in order that the ability of such firms to compete abroad shall not be interfered with.

To such existing industrial undertakings belong:

(*a*) Rectification of spirits.
(*b*) Malt manufacture and distilleries for export.
(*c*) Lard refineries for export.
(*d*) Rice mills.
(*e*) Meat packers for export.
(*f*) Ship yards which in the future will be located in the Free Port.
(*g*) Sugar refineries.

3

The administration of customs and duties—with the exception of territory located in Holstein and Cuxhaven—will be entirely in the hands of Hamburg officials.

Hamburg customs officials are relieved from the regulations governing Military Inspectors.

The costs of maintaining directing officers of customs shall be paid by Hamburg. The pay to be given all other officials with consideration for local conditions shall conform to a norm to be agreed upon.

Existing customs buildings, insofar as the same may be of any further use, will be transferred to Hamburg.

The use to which other customs and revision buildings outside of the new area may be put is reserved for further agreement.

The tariff union (Zollgemeinschaft, which includes the German Empire and Luxembourg), assumes the payment of pensions to Hamburg officials of the Indirect Tax Collection Office who may be left without employment (because of the change).

4

A new set of rules and regulations covering the clearance of goods in the Hamburg tariff harbor (that part not included within the Free Port), with due respect to local conditions of tide, ice, etc., will be published.

5

This paragraph says that the existing general regulations governing the administrations of customs by the tariff union (the Empire and Luxembourg) will be changed where necessary to conform to the new situation.

6

The German Empire will contribute to the costs of construction and expropriation involved in the incorporation of Hamburg, and to the costs of such changes in existing commercial and transportation institutions caused thereby, a sum not to exceed 40,000,000 marks.

To ascertain the sum which the Empire is to pay, the Senate of Hamburg will cause to be made, as soon as possible, an estimate of the expense to be incurred and a general plan of execution, and Hamburg will agree with the Empire concerning the same.

Half of the expense, as ascertained by the Senate and the House of Burghers, but not to exceed 40,000,000 marks, will be paid into the Hamburg Treasury within ten years in annual instalments. The first instalment will be paid one year after the estimate approved by the Senate and the House of Burghers has been received. The other instalments will follow annually thereafter following the statement from the government of Hamburg that the work is progressing in accordance with the agreement.

7

The Senate will see to it that the work progresses with the least possible delay.

The incorporation of Hamburg will take place after the first day of October, 1888, at a time to be agreed upon by the Bundesrat.

8

Rules governing the collection of supplementary taxes (Nachsteuer) shall be the same as agreed in the case of Lübeck.

9

In case the Bundesrat changes the present Common Custom House before the Incorporation, in the interim the collection of taxes will be performed by Prussia.

10

This agreement, after the agreements mentioned in the introduction have been ratified, shall be submitted to the Bundesrat for its approval.

As soon as this approval has been received the Senate of Hamburg, in accordance with Art. 34 of the Imperial Constitution, will make a request to the Bundesrat to be incorporated within the German Customs Union on the conditions of this agreement.

It is expressly reserved, however, that the act of the Bundesrat shall be effective only after the Reichstag has voted the contribution to the expenses of the incorporation as agreed in Paragraph 6 above.

(Signed)	BITTER	VERSMANN
	SCHOLZ	W. O'SWALD
		KRÜGER

In addition to the above agreement a codicil or commentary document makes more explicit some of the articles and enters somewhat into detail. As there is nothing new in the principles involved, it is not necessary to give this document here.[1]

There was still a possibility, however, that Hamburg might be cut off from the sea merely by the Elbe being closed to ships which had not undergone a customs revision on entering the Customs Union Territory between Hamburg and the sea. In order to prevent this, the Hanseatic Resident Minister, Dr. Krüger, wrote a letter to Prince Bismarck, then Chancellor of the German Empire, to clear up this point. He received the following reply:

Berlin, May 27, 1881.

I have, Sir, the honor to reply to your letter of the 25th inst. that it does not seem advisable to leave the customs regulations of the lower Elbe in the present condition. However, I share the view of the Senate of Hamburg that the present arrangement by which ships proceeding from the sea to Hamburg and from Hamburg to the sea in transit, under the customs flag or customs lights, are to be free from customs inspection, is a permanent institution.

I do not doubt that this institution, the execution of which can be put almost entirely under the control of pilots sworn as customs officials, will be satisfactory in practice and will offer the customs sufficient security. Should an unexpected change become necessary, with future experience, I for my part will favor only such an institution as will meet the requirements of free communication between the Free Port of Hamburg and the open sea—the Free Port in its present or in its future restricted form—as completely as the present arrangement of the Customs flag. Also I shall not fail to notify the Senate of an opportunity to present its views and suggestions.

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[1] Neben-Protokoll, May 25, 1881.

* * * * * *

The Imperial Government will be glad to coöperate with Hamburg in the future in the arrangement of tariff questions connected with the Free Port position of Hamburg and will be able to go further in this aid if Hamburg refrains from using technical questions as a means for furthering political ambitions which would put upon the government the duty of defending its constitutional rights.

V. Bismarck.

To
The Hanseatic Resident Minister
Dr. Krüger, Esq.

The case of Bremen was similar in every respect as to legal and historical background. However, some of the details in the conditions of incorporation were different and perhaps therefore of interest.

The Senate of Bremen sent a request to the Bremen House of Burghers that they approve the suggestions made in the report of the Committees of the Bundesrat on "Tariffs and Taxes," on "Commerce and Trade," and on "Finance." The important part of the Bundesrat report reads as follows:

"In case Bremen requests to be incorporated into the German Customs Union on renouncing the particular rights and privileges accorded in Art. 34 of the Imperial Constitution, the Bundesrat will agree to the following:

1. That the territory of the Free and Hanseatic City of Bremen without the Common Tariff Boundary of the Empire will be included or incorporated into said boundary on the same day as that of Hamburg. In case the Free and Hanseatic City of Bremen desires to be incorporated at an earlier date, such action remains open to discussion.

2. The harbor area and the petroleum harbor as noted on the accompanying map remain excluded from this action and outside of the tariff boundaries of the Empire.

3. Coincidentally with the incorporation of Bremen within the Tariff Boundary, the lower Weser will be included within the said Boundary.

4. The area to the North of Bremen and on the right bank of the river, as denoted on the accompanying map, will be secured against the passing of merchandise (zollsicher algeschlossen) and shall be regarded as foreign territory according to the laws of the Union. Within this area, which will be subject to customs regulation and control only

from without, and which will be equipped with all the requisite harbor works, quays, and warehouses, all movement of ships, loading, unloading, and handling of freight shall be freed from any customs control, supervision, or interference whatsoever. However, books shall be kept in accordance with commercial usage, from which may be seen at any time the nature and quantity of all goods stored or held within the zone, and the customs officials shall have access to the inspection of such books at any time.

5. For all ships plying between Bremen and the sea, Bremen will be a port of entry in accordance with Sections 74 and following of the customs regulations of the Customs Union. The function of the officials empowered to receive customs declarations and to accompany dutiable goods may be delegated to pilots duly sworn as customs officials.

For vessels plying between Bremen and Bremerhaven (a distance of 54 miles), formalities shall be simplified as much as possible.

Regulations concerning the navigation of the Weser shall be formulated with due regard for the commercial interests of Bremen.

Of the same nature and in the same spirit the present customs regulations of the Customs Union shall be revised to accommodate the new position of Bremen and in particular the movement of tobacco samples.

Also all changes which have been applied to Hamburg shall also apply to Bremen insofar as the conditions which such regulations are to cover remain the same.

6. Industrial enterprises which are dependent on duty-free raw materials from abroad shall be given every possible assistance. In particular, petroleum refineries, tobacco factories, and breweries which export and renounce their domestic business within the Customs Area shall be assured the continuation of their industries and the ability to compete abroad in every possible manner.

7. The entire customs and taxing administration in all the area of the State of Bremen shall be administered by the Free and Hanseatic City of Bremen.

The expenses of the Customs Administration shall be refunded to Bremen.

The pensions to Bremen tax officials who may be retired from service in the administration of the indirect taxation of Bremen shall be paid by the Customs Union.

The customs buildings which have been built at the expense of the Customs Union will be transferred to Bremen without cost if the same continue to serve customs uses.

8. The Empire will contribute to the costs of harbor works, quays, purchase of land, and other institutions required in the Incorporation of Bremen and the changes in existing commerce and traffic to a maximum sum of M. 12,000,000.

To ascertain this amount the Senate of Bremen will cause to be made a cost estimate and general plan and will agree on the same with the Imperial Chancellor.

This contribution will be paid into the treasury of Bremen in four equal instalments, the first of which will be paid one year after notice has been given of the amount of the same by the Senate and House of Burghers of Bremen, and the following instalments each year after notice has been given that the work is in satisfactory progress.

(Signed by the members of the three Bundesrat Committees.")

* * * * * *

May these chapters on ports help to point the way to a greater American understanding of the problems involved and to renewed energy of execution. Then will American ports be not only equal to, but far better than any ports yet known abroad.

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